Communicating the value proposition of new deep-tech ventures to investors
A design science study to help new deep-tech ventures better communicate their value proposition to investors

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Abstract

Deep-tech startups have the potential to solve grand societal and environmental challenges, create new industries and disrupt existing industries by combining entrepreneurial knowledge with advanced patent-protected technologies. However, around 90% of startups fail. To decrease this failure rate, initiatives to support startups, including incubators, accelerators, and venture builders, are increasing in numbers. On average, ventures participating in a venture-building program show a growth rate 26% higher than ventures not participating in such a program. Deep-tech products are associated with long development times and high development costs, requiring significant investments before generating revenue. Investors within deep-tech are impact-focused and often lack the in-house technical expertise required for assessing the potential of deep-tech value propositions, making it difficult for ventures to attract funding. Therefore, it is essential to develop a clear value proposition that is validated with future customers and includes the desired impact on society and the environment to ensure the customer experiences a problem addressed by the technology. This allows for proper communication of the value proposition and the articulated narrative to investors, which could increase the likelihood of receiving an investment. Therefore, this research focusses on developing an evidence-based framework targeted at better communicating the value proposition of deep-tech ventures to investors.

For this, a design science approach is used, including a theoretical and empirical analysis. These will serve as input for formulating design principles and requirements, which are the foundation for the initial solution design, which targets the sustainability aspect of a value proposition. The final solution design is developed through an iterative process for which nine alpha tests and three beta tests are performed. The final solution design consists of four phases, value proposition development regarding the customer-firm relationship, the impact of the value proposition on society and the environment using the SDGs, developing a Theory of Change, and developing impact KPIs based on the developed Theory of Change. This framework allows deep-tech ventures to better communicate their value proposition to investors.

The study proposes several theoretical contributions regarding communicating the value proposition to investors, focusing on impact and sustainability. Additionally, the limitations of this study and potential future research directions are discussed. Finally, the practical implications and recommendations are provided.
Executive summary

Deep-tech is associated with solving grand societal and environmental challenges (Portincaso et al., 2021). Deep-tech venture builders, such as HighTechXL for which this research was conducted, source technologies and talents and provide guidance in the venture-building program to streamline and accelerate the development of deep-tech ventures. Deep-tech ventures are associated with a long and deep valley of death, requiring significant capital before revenue is created. For attracting external capital, deep-tech ventures should attract the attention of investors. Most investors operating within deep-tech are impact investors. To attract the attention of investors, deep-tech should communicate a well-articulated value proposition highlighting the products and services that are of value to the customer and other stakeholders, such as society and the environment. This communication should be done in a way that is understandable for investors, which often lack in-house technical expertise, and should articulate the whole narrative of a venture. This value proposition should be based on what value is perceived by the customer and should be validated after proposing the value proposition to said customer. Products and services that create value for the customer are always at the foundation of a value proposition. However, early-stage deep-tech ventures often have not yet developed a product. When this lack of a developed product is combined with the long development times and high development costs of a product, this results in high uncertainty about the Return on Investment (ROI). Therefore, when interacting with investors, they should not only have trust in the communicated value proposition, but the investor should also trust the venture team to be able to develop and deliver the communicated value proposition. As mentioned before, most investors operating within deep-tech are impact investors. A framework often used by impact investors is the SDGs, a list of 17 goals to “transform our world and to improve people’s live and prosperity on a healthy planet” (United Nations, 2019). Therefore, it is essential that the value proposition of a deep-tech venture addresses the value created for society and the environment and that it is communicated in a way that is easy to understand for investors. A well-developed, and validated value proposition incorporating created impact on environment and society, that is communicated in a way easy to understand for investors often lacking in-house technical expertise allows investors to better assess the potential of a technology. This could increase the likelihood of receiving investments, which are required for bridging the valley of death. Therefore, this research focusses on developing an evidence-based framework that helps early-stage deep-tech ventures better communicate their value proposition to investors.

For developing this evidence-based framework, the study uses a design science approach. Within this study, a theoretical and empirical analysis is performed. The theoretical analysis provided insights into the scientific literature about existing methods for communicating the value proposition to investors. For this, the theoretical focused on communicating the value proposition through semantics, visuals, and tangibles, after which more general investor communicated was researched. The empirical analysis provided insights into how HighTechXL and its ventures currently communicate their value proposition to investors. For this, the same structure as in the theoretical analysis was used. The findings from the theoretical and empirical analyses served as input for formulating the design principles and design requirements. These design principles served as the foundation for the final design solution. The final design solution was developed through an iterative process and went through nine alpha tests and three beta tests.

The theoretical analysis provided insights into what scientific literature states about existing methods to communicate the value proposition to investors. Before a value proposition can be communicated to investors, the value proposition should be developed. Therefore, the
theoretical analysis also includes methods for developing the value proposition. First, the evolution of the definition of value proposition is discussed. A value proposition includes all products and services that create value for the customer (Osterwalder et al., 2014). Later, other things, such as perceived, ethical, emotional, economic, functional, and symbolic value, were proposed to be included (Barnes et al., 2009; Rintamäki et al., 2007). So far, the value proposition has mainly focused on the customer-firm relationship. It was proposed that a value proposition should also include its effect on external stakeholders, such as the environment and society (Bocken et al., 2013; Den Ouden, 2012). Afterward, several tools for developing the semantic side of a value proposition were discussed, including the research of Straker and Nusem (2019) and the research of Straker and Wrigley (2018). For communicating the value proposition through visuals, several tools were discussed, including the Value Proposition Canvas (Osterwalder et al., 2014), the value mapping tool for sustainable business modeling (Bocken et al., 2013), and a tool for building sustainable value propositions for multiple stakeholders (Vladimirova, 2019). Most of these tools were mainly applicable to the ideation and analysis stage and did not allow for (effective) communication of the value proposition (Vladimirova, 2019). Afterward, the applicability of simulations as a form of value proposition communication within deep-tech was discussed.

Then, communicating the value proposition through tangibles was discussed. The importance of early-stage prototype development was emphasized, and the process of Design-Build-Test-Learn (DBTL) cycles, specifically developed for deep-tech, was elaborated upon. Afterward, the necessity of a well-functioning ecosystem for deep-tech product development was highlighted, and the traits and actors associated with such an ecosystem were described. Finally, as products and services form the foundation of a value proposition, which early-stage deep-tech ventures often do not have, more general investor communication is discussed. Signal theory has shown to be a literature stream applicable to early-stage deep-tech ventures. Within signal theory, ventures try to send (positive) signals to external parties, in this case investors, to decrease information asymmetry to create trust. An overview of relevant signals is provided in section 3.5. Additionally, the increasing relevance of creating impact is described, which can be denoted by, among others, the increase in impact investments and the introduction of the Sustainable Finance Disclosure Regulation (SFDR). Moreover, two frameworks often used by impact investors, SDGs and the Theory of Change, are explained.

The empirical analysis provided insights into the methods currently used by HighTechXL and its ventures to communicate the value proposition to investors. It also includes methods for developing the value proposition for the same reason described in the previous paragraph. The empirical analysis was performed through participant observations, interviews, and field notes. It describes the structure of the venture-building program and provides an overview of the current templates, assignments, and workshops used for developing the value proposition and communicating it to investors. It also describes what signals from signal theory can be sent by the ventures and maps out the deep-tech ecosystem of the Eindhoven region.

The findings from the theoretical and empirical analysis were used as input for formulating the design principles and design requirements. An overview of the design principles is provided in figure 1. The design requirements included that the framework should link the value proposition of a venture to the SDGs and allow communication of the SDG impact to investors. It should be evidence-based and help in better communicating (part of) the value proposition to investors. It should be easy to use for the venture teams and HighTechXL employees and should be easy to implement within the existing set of tools, templates, and workshops by HighTechXL. It must adhere to the current venture-building process of
HighTechXL, and the framework must focus on developing the value proposition of new deep-tech ventures and communicating it to investors.

The final design solution consists of four phases. The first phase focuses on developing the value proposition regarding the customer-firm relationship for which the Value Proposition Canvas (Osterwalder et al., 2014) is used. The second phase extends to the Value Proposition Canvas and includes a value proposition's impact on society and the environment. For this, a societal and environmental profile are included with a structure similar to the customer profile from the Value Proposition Canvas. The SDGs are the foundation for the societal and environmental profile to map the created impact, and it considers both positive and negative contributions. The third phase focuses on developing a Theory of Change, a framework often used by impact investors. For developing the Theory of Change, the output from phase 2 is used for defining the desired impact and outcomes, which are two of the main building blocks of a Theory of Change. The Theory of Change turns this desired impact into concrete actions to be taken by the venture. The fourth and final phase is implemented to develop impact KPIs based on the Theory of Change. Investors require impact KPIs to assess and monitor ventures' impact on society and the environment. For this, seven requirements are formulated to which the impact KPIs of the venture have to adhere.

The final design solution was developed through an iterative process and went through nine alpha tests with HighTechXL (ex)staff members to validate the added value of the design solution to HighTechXL and validate readiness for beta testing. Additionally, three beta tests were performed to test the applicability and added value for the ventures. The beta tests were performed with upper management of ventures of HighTechXL that all received funding (Subsidy and/or equity funding), operating in different industries and of different maturity levels. The developed framework was of added value, generating new insights, and was easy to use. It adhered to the current venture-building process of HighTechXL and was easy to implement as Phases 1 and 3 are tools already used within HighTechXL.
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1. Introduction

Deep-tech is described as "disruptive solutions built around unique, hard-to-reproduce, scientific or technological advances" (Chevalier, de la Tour, Duportet, Harlé & Soussan, 2017, p.6) and often addresses big societal challenges (Portincaso, Gourévitch, de la Tour, Legris, Salzgeber & Hammoud, 2021). It has the ability to propose products that are ten times better than existing solutions rather than 10% improvements (Portincaso et al., 2021).

However, these high potential returns also come with higher risks, as argued by Portincaso et al. (2021), who compare deep-tech to Software as a Service (SaaS) and Biotech. For example, the technology risks arising from deep-tech are significantly higher than in SaaS, as a minimum viable product (MVP) is multiple times as expensive, and SaaS is more easily scalable (Portincaso et al., 2021). In addition, SaaS allows for more traditional references, including customer base, burn rates, and revenue models comparable to competitors, while deep-tech does not (yet) allow for these references (Portincaso et al., 2021). Similarly, Biotech has a low market risk compared to deep-tech. Also, Biotech supports more traditional product development processes, such as clinical trial gates, while deep-tech does not (yet) allow for this type of process (Portincaso et al., 2021). Finally, deep-tech usually includes longer investment horizons of 10-20 years before the possibility of an exit (Portincaso et al., 2021). After the technology leaves the lab, the absence of either a low-technology risk or a low-market risk, combined with the long investment horizon and the high development costs and time of an MVP resulting in a high uncertainty about ROI can make it difficult for deep-tech ventures to attract funding.

This period in which the technologies have left the lab but are not commercially available yet is called the "valley of death." The valley of death can be linked to certain technology readiness levels (TRLs), a widely used classification method initially developed by NASA. The TRLs are defined as "a systematic measurement system that supports assessments of the maturity of a particular technology" (Mankins, 1995). The TRLs start at TRL 1 and end at level 9. Among those TRLs, the valley of death ranges from TRL 4 to TRL 7. The definition of each of these levels is shown in table 1.

Table 1: Technology readiness levels (Mankins, 1995.)

<table>
<thead>
<tr>
<th>Technology readiness level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRL 1</td>
<td>Basic principles observed and reported</td>
</tr>
<tr>
<td>TRL 2</td>
<td>Technology concept and/or application formulated</td>
</tr>
<tr>
<td>TRL 3</td>
<td>Analytical and experimental critical function and/or characteristic proof-of-concept</td>
</tr>
<tr>
<td>TRL 4</td>
<td>Component and/or breadboard validation in a laboratory environment</td>
</tr>
<tr>
<td>TRL 5</td>
<td>Component and/or breadboard validation in a relevant environment</td>
</tr>
<tr>
<td>TRL 6</td>
<td>System/subsystem model or prototype demonstration in a relevant environment</td>
</tr>
<tr>
<td>TRL 7</td>
<td>System prototype demonstration in the application environment</td>
</tr>
<tr>
<td>TRL 8</td>
<td>The actual system completed and 'application qualified' through test and demonstration</td>
</tr>
<tr>
<td>TRL 9</td>
<td>The actual system has proven through successful implementation</td>
</tr>
</tbody>
</table>
Within the deep-tech sector, the valley of death is especially long and deep due to the complex technologies causing long investment horizons, long time-to-market, long time before first revenue, and high costs of development of an MVP. In addition, it can be difficult to communicate the value proposition of deep-tech ventures as often, yet-to-be-developed markets are targeted, there is no MVP, and no initial revenue (Portincaso et al., 2021). Additionally, 81% of deep-tech ventures have confirmed that "investors, on average, lack scientific/engineering expertise to assess deep-tech potential" (Portincaso et al., 2021, p. 13). This is because potential investment funds often do not have in-house experts or other accessible experts who can adequately assess the technology and clearly communicate its potential. This lack of expertise is especially damaging in combination with the limited time investment funds have to review the individual value propositions of each venture (Portincaso et al., 2021). In the past, these funds had to seek new deals actively. However, some have switched to the more passive role of 'deal-receiver' as their track record attracts deals by itself (Portincaso et al., 2021). Finally, Portincaso et al. (2021) state that "Both nascent and complex, deep-tech lacks an articulated narrative and, as a result, suffers from a void of understanding or inaccurate reputation" (p. 13). By increasing the level and clarity in communicating the value proposition to investors and incorporating an articulated narrative, these investors could be allowed to better understand the venture's value proposition and assess the technologies' potential. The reasons for this will be further elaborated on below.

Payne et al. (2017) describe a value proposition as a “strategic tool that is used by a company to communicate how it aims to provide value to customers.” (p. 1) that is crucial to the process of creating value and has significant implications for performance (Payne & Frow, 2005). To develop a competitive value proposition, the perspectives of perceiving and proposing value are essential (Landroguez et al., 2013). The prior is focused on taking a customer’s perspective and customer perceived value. The proposing perspective is focused on the creation of this perceived value and using the value proposition as a strategic tool. The first step for developing a competitive value proposition is to develop a deep understanding of the customer and perceive what a customer values (Rintamäki & Kirves, 2017). Holbrook (1994) and Sheth, Newman, and Gross (1991) conceptualized five types of value functional, emotional, social, conditional, and epistemic value. The first four are also integrated into tools used in practice, such as the Value Proposition Canvas (Osterwalder et al., 2014), and are further elaborated upon in section 3.3.1. The second step for developing a competitive value proposition is proposing the perceived value, reflecting the value that is wanted by the targeted customer segment (Rintamäki & Kirves, 2017). This serves two primary purposes, positioning the value propositions in a customer’s mind and focusing the activities of a company on strategic customer value creation (Webster, 2002). These steps are an iterative process which is outlined below in figure 2. By following the iterative process above, a deep understanding of the customer is achieved, and it is ensured the value proposition targets a problem experienced by the targeted customer. Additionally, through the iterative process in which the proposed value proposition is verified with targeted customers, it is ensured the experienced problem is addressed through the proposed value proposition and adequate value is created for the customer. Such a value proposition can increase the competitive advantage of a company (Rintamäki & Kirves, 2017).
At later stages, or in other industries requiring less time and capital for initial product development, investors can validate a value proposition by considering the market traction through sales, revenue, or user base (Bernstein et al., 2017). However, early-stage deep-tech ventures often have not developed a product, do not generate revenue from sales, and therefore also do not have a user base due to the long development times and high development costs associated with deep-tech (Portincaso et al., 2021). This denies investors the possibility to validate the effectiveness of an early-stage deep-tech venture’s value proposition through market traction. Therefore, other methods of validation should be adopted. If a deep-tech venture performs the iterative process described above, its value proposition is validated by the targeted customer to deliver value on a problem experienced by said customer. In practice, this could, for example, be through the form of a Letter of Intent (LoI) which is “a document declaring the preliminary commitment of one party to do business with another” (Bloomenthal, 2022b) and often includes specific requirements to be met that are co-developed with a potential customer. An LoI proves the to be developed technology solves a problem the customer is willing to pay for and strengthens and validates the proposed value proposition. Communicating a validated value proposition provides a signal of third-party endorsements which has been shown to increase the likelihood of attracting external investments (Courtney et al., 2016; Plummer et al., 2015; Stuart et al., 1999). An overview of other relevant signals and their applicability to early-stage ventures is provided in section 3.5.

By providing a clear and validated value proposition, a venture shows several things, including that the problem described is perceived by the targeted customers, the proposed value proposition adequately addresses this problem, and, if an LoI or similar is included, that potential customers are willing to pay if certain requirements are met. While early-stage deep-tech ventures are unable to show market traction, a well-developed and validated value proposition highlights how a venture’s products and services aim to create value for the customer and show interest and willingness-to-buy from potential customers, signaling third-party endorsements. Investors are often unable to determine the potential of a technology due to the lack of in-house scientific and/or engineering expertise (Portincaso et al., 2021). By communicating a value proposition validated through the iterative process above, the venture takes part of this responsibility, and the potential of a technology is validated by potential customers. This allows investors to better understand the value
proposition and assess the technology’s potential, which could increase the likelihood of obtaining external investments and bridging the valley of death.

Additionally, recent research has challenged the definition of “customer.” This research broadens what customer value embodies, incorporating other stakeholders and having a more societal perspective, including aspects such as the environmental value, societal value, and ethical value (Porter & Kramer, 2011). Deep-tech ventures often aim to generate significant environmental and/or societal value, as deep-tech is associated with solving grand societal and/or environmental challenges (Portincaso et al., 2021). Deep-tech funds are also often focused on making societal and/or environmental impact besides generating profit. A framework often used by investors related to impact is the SDGs, a list of 17 goals “to transform our world and to improve people’s live and prosperity on a healthy planet” (United Nations, 2019). Impact investing is a rapidly growing phenomenon and has increased from 16 billion euros in 2020 to 39 billion euros in 2022 globally (Dealroom, 2021). The importance for deep-tech ventures to highlight the SDG and societal contributions is emphasized by Portincaso et al. (2021), who also state that deep-tech lacks an articulated narrative resulting in a lack of understanding by investors. By extending the definition of ‘customer’ and incorporating societal and environmental value and SDG contribution, a better narrative could be created about how a deep-tech venture intends to create this societal and/or environmental value, decreasing the lack of understanding by investors. This is especially relevant for deep-tech/impact investors due to their focus on SDGs and generating impact besides generating profit. Undoubtedly, this focus on social and environmental value should be combined with the more traditional definition of “customer” described in the previous paragraph and taking the customer perspective to co-develop product requirements as this customer should still put money on the table (Rintamäki & Saarijärvi, 2021). By combining the perspectives described in this and the previous paragraph, the validated value proposition, intended impact, and the narrative can be better communicated, which could increase the likelihood of receiving investment and bridging the valley of death.

Within HighTechXL, a deep-tech venture builder located in Eindhoven (The Netherlands), the valley of death has thus far especially been addressed from the funding side, from which one of the design solutions is currently implemented. This implementation is done in the form of an early-stage fund targeting the need for pre-seed and seed investments within deep-tech and is based on the thesis of Mittelmeijer (2020). However, the valley of death has so far not been addressed from the venture’s value proposition perspective for communicating with investors. The HighTechXL case, as the empirical setting of this master thesis project, is described in more detail in section 1.3.

1.1 Research question
The goal of this research is to construct a framework that deep-tech venture builders can implement to let its deep-tech ventures structurally improve the communication of value propositions to investors. The development of a value proposition and the communication of a value proposition are two inherently different things. This research will focus on improving the communication of a deep-tech venture’s value proposition to investors. However, before a value proposition can be communicated to investors, it should first be developed by the venture. Therefore, methods for developing a value proposition will also be reviewed, as these are required before a value proposition can be communicated and therefore contribute to the communication of a value proposition to investors. This developed framework could result in a combination of both process improvements and a tool. The main research question therefore is:
RQ: What methods can deep-tech venture builders use to better communicate its deep-tech venture’s value proposition to investors?

To answer the main research question, several sub-questions are formulated, which have to be answered first. The first sub-question will be answered through a literature review. The main research question is about communicating the value proposition to investors, but for effective communication of a value proposition, it should first be developed. Therefore, the first sub-question also considers methods for developing a value proposition:

SQ1: What does the scientific literature state about existing methods to develop value propositions and communicate them to investors?

The chapter regarding SQ1 will be written based on a literature review. First, the current value proposition landscape will be mapped, including new developments in methods of communicating the value proposition. It will include methods in three categories semantics, visuals, and tangibles. Afterward, communication to investors will be discussed. Concepts that are introduced include the developments in the definition of value proposition, visual tools for communicating a value proposition, simulations, DBTL cycles, deep-tech ecosystems, signal theory, information asymmetry, SDGs, and the Theory of Change.

SQ2: How do HighTechXL's deep-tech ventures currently develop their value propositions and communicate them to investors?

The chapter regarding SQ2 will be written based on an empirical analysis to get a deeper understanding of how a deep-tech venture builder currently communicates a new venture’s value proposition to investors. This analysis will be executed through participatory action research, which includes, participant observations, interviews, and field notes. For this data, HighTechXL staff members, staff members of HighTechXL's ventures, and other experts will be contacted. By combining the theoretical analysis and the empirical analysis from SQ1 and SQ2, SQ3 will be answered.

SQ3: How can HighTechXL design and implement an evidence-based framework that structurally improves the communication of its deep-tech venture’s value proposition to investors?

The final sub-question will be answered to construct an evidence-based framework for more clearly communicating the value proposition of HighTechXL’s new deep-tech ventures to investors. In this respect, design principles and requirements will be formulated based on the literature and requirements of HighTechXL's management. These design principles and requirements will help guide the development of the framework.

1.2 Definition of concepts

1.2.1 New ventures

The importance of new venture creation has increased, and in the early twenty-first century, an increase in accelerators that promote high-potential, high-growth startup firms can be observed (Frimodig & Torkkeli, 2017). Osterwalder (2014, p.16) describes new ventures as "Individuals or teams setting out to create a great value proposition and business model from scratch." Another description of a new venture, according to (Jin et al., 2017), is a company in its early phases of growth and development. Activities that are usually related to these early phases of growth and development include commercializing the first service/product, setting up internal structures and processes, and developing the initial customer base (Klotz et al., 2014). Quantifying whether a venture is still in its early phases of growth and development can be done on different parameters, of which three will be described in this
paragraph. The first parameter is the period since the founding of the company. Amason, Shrader & Venturing (2006) used a period of a maximum of six years as these are the most crucial years for the success of a new venture. Hu and Zhang (2012) use a period of five years. Gimenez-Fernandez (2020) assumes a maximum period of three years, combined with a maximum of 250 employees. The number of employees working within the venture is then also the second parameter that is often used. A third parameter that is used within the literature is the progression in relation to obtained/required funding (Frimodig & Torkkeli, 2017)

The conditions under which new ventures have to perform are often dynamic, complicated, and unpredictable (Chandler et al., 2005), especially due to their limited financial and human resources in combination with the small size and young age of the venture (Li & Zhang, 2007; Lu et al., 2010). New ventures contribute significantly to the economy and society, as they contribute to economic development, regional development and the creation of jobs (Bellavitis et al., 2017; Gilbert et al., 2006). In addition, new ventures create new markets and industries by developing new products and technologies (Megginson et al., 2004). New ventures focused on technology development focus more on accelerated growth than ventures with traditional innovation processes (Freeman & Engel, 2007). Based on the long development times associated with deep-tech described in section 1.2.2 and the reviewed literature in this section, the following definition for new ventures is derived for this study.

New ventures are ventures that exist for a maximum of 6 years and with a maximum of 250 employees.

1.2.2 Deep-tech

Deep-tech is a novel term that has emerged over the past few years. Therefore, relatively little academic research has been done on this topic. One collaboration that has produced several reports about the status of deep-tech is the partnership between Boston Consultancy Group (BCG) and HelloTomorrow. They have described deep-tech as disrupting solutions built around unique, hard-to-reproduce scientific or technological advances (Chevalier, de la Tour, Duportet, Harlé & Soussan, 2017). A later report by BCG and HelloTomorrow observed that deep-tech still has various definitions, and no consensus has been reached as it is a nascent term (Portincaso et al., 2021). Deep-tech often originates from scientific research institutes and addresses problems in ways impossible for market-ready solutions (Priego, Wareham, Romasanta & Rothe, 2021). In addition, deep-tech is often based on complex hardware requiring high levels of skill, significant investments, and long-development times to develop and scale up ventures (Harlé et al., 2017; Portincaso et al., 2021; Priego et al., 2021). Moreover, deep-tech has the potential to solve grand societal and environmental challenges (Portincaso, et al. 2021). These factors, combined with the challenge of yet-to-be-developed commercial applications (Harlé et al., 2017), create high barriers to entry on markets for deep-tech solutions (Portincaso et al., 2021).

Deep-tech ventures operate in various industries, which include, but are not limited to: AI, quantum computing, carbon capture, transportation, photonics, energy, agriculture, health, advanced materials, and industry 4.0. It often tries to address big societal efforts and, by doing so, can have a high impact (Portincaso et al., 2021). To summarize, Deep-tech is in this study defined as:

Deep-tech are disruptive technological hardware-based solutions originating from research with the potential of solving grand societal and environmental challenges. Additionally, it is associated with long development times and high development costs before commercialization.
1.2.3 Venture builder

A venture builder, also referred to as a startup factory or company builder, is a phenomenon that has emerged relatively recently. Therefore, little academic research is available on this topic. Two concepts similar to venture builders are incubators and accelerators. Those two terms will be briefly explained, after which the main differences between them and venture builders will be provided. Bergek and Norman (2008) define incubators as "Organisations that supply joint location, services, business support and networks to early-stage ventures" (p. 22).

In the 1970s, these incubators started to emerge in technology and science-focused coworking parks in the US. In this period, their offerings included office space, brokerage, consulting, and other basic services (de Alvarenga, Canciglieri & Zeny, 2019). Later, these incubators expanded their offerings and included, but were not limited to, providing capital, marketing, and recruitment, but varied per incubator (Grimaldi and Grandi, 2005). This increase in offerings proved to be successful, which caused a rise in the number of incubators (Leblebici and Shah, 2004). The incubators typically offered their service in exchange for equity in the company, and the duration of the program could be from a few months up to several years. The companies applying can both be in the early and later stages. Four main characteristics of incubators defined by Köhler and Baumann (2016) are:

1) Low equity-share in portfolio companies
2) Realistic matching of resources and decision-making process
3) Strong incentives for entrepreneurs
4) Short-term orientation

Köhler (2016) defines accelerator programs as "company-supported programs of limited duration that support cohorts of startups during the new venture process via mentoring, education, and company-specific resources" (p. 348). Accelerator programs generally last a shorter period, ranging from weeks to a few months, and the structure of these programs is often more systematic than those of incubators. There is often a higher competition to participate in accelerators, and the selection procedure is stricter. The end point of an accelerator often is 'demo day', during which participants can pitch to potential investors (Scheuplein & Kahl 2017). The five main features of business accelerators defined by Miller and Bound (2011) are:

1) An open but highly competitive application process
2) A provision of pre-seed investment in exchange for equity
3) A focus on small teams
4) Time-limited support
5) Mentoring through cohorts

Alvarenga et al. (2019, p. 5) define venture builders as organizations that "actively assemble startup firms in a factory-like manner, i.e., with a focus on speed, efficiency, and scale, and using standardized processes and shared resources." Venture builders differ from incubators and accelerators in the moment they start the journey. Venture builders do not include existing ventures in their program, but source the technology and the staff members themselves. They 'build' the ventures from the start. Often the programs are also structured and focused on developing the technology and finding investors to scale up the companies. Venture builders structurally provide funding in exchange for an equity-share in the new ventures. As venture builders found the ventures themselves, this equity-share is often larger than the equity-share taken by incubators and accelerators (Szigeti, 2016). This larger equity-share often results in a higher return on investment (ROI) for investors in the case of successful exits. Another characteristic of venture builders is the presence of a strong
network that helps identify and effectively use a vast array of resources. This can be denoted by the fact that Michaelis et al. (2019) state the growth rate of ventures within venture builders, on average, was 26% higher than the growth rate of ventures within accelerators. Based on the literature reviewed in this section, venture builder will be defined as:

*Venture builders are organizations that build ventures from the start through a structured program. They are responsible for sourcing and selecting technologies and co-founders, who subsequently start the program in exchange for equity.*

### 1.2.4 Value proposition

Osterwalder et al. (2014, p. 43) define a value proposition as "an overall view of a company's bundle of products and services that are of value to the customer." Business accounting was the first to introduce the term 'value proposition', after which strategy for business innovation introduced it. Currently, it is widely used in generating business models, building startups, and it is being adopted by designers and other industries (Wormald, 2013). Chesbrough and Rosenbloom (2002) define the value proposition as 'the value created for users by the offering based on the technology" (p. 553). This definition was later criticized because the creation of value is not caused by technology only (Gassmann et al., 2016). The method used for communicating the value proposition is of significant importance, as this influences the perceived value of a customer, directly affecting the willingness to pay (Priem, 2007; Priem & Wenzel, 2018). Another aspect not incorporated so far are the perceived costs. This not only includes monetary costs but also includes, for example, switching costs and perceived risks (Barnes, Blake & Pinder, 2009). Barnes et al. (2009) further describe the perceived value as benefits minus costs, where benefits are defined as 'the outcomes and experiences of value to the client and not the features of the offering' (p. 29). This shift in focus from product features to customer value is the general tendency within the academic literature. Rantimäki, Kuusela, and Mitronen (2007) define perceived value along different, more intangible dimensions, including ethical, emotional, economic, functional, and symbolic value. To further extend the range of the value proposition, Den Ouden (2012) and Bucknell Bossen and Kottasz (2020) stated that not only an organization and its direct customers should be included. Other entities impacted by the value proposition, such as the climate or society, must also be included. This is confirmed by Molling and Klein (2020), stating the value proposition requires to be constantly innovated as technology advances to incorporate society and the environment.

The Value Proposition Canvas is a visual tool designed to help ventures develop their value proposition for customers. It is part of the Business Model Canvas (BMC), developed by Osterwalder (2010) in the form of a book. Within the BMC, the value proposition is determined by the fit between the customer profile and the value map (Osterwalder et al., 2014). The value map describes the form in which value is created for the customer. The products and services, gain creators, and pain relievers are formulated for this. In the customer profile, a customer or customer segment is described. This is done by formulating the gains, pains, and jobs the customer has. The value proposition is successful, and fit is achieved when the pain reliever and gain creators solve the customer pains and create customer gains formulated in the customer profile (Osterwalder et al., 2014). This is one of the most common uses of the value proposition. However, it does not incorporate other desirable aspects, such as the value proposition's effect on society and the environment as proposed in other literature about value proposition (Bocken et al., 2013; Bucknell Bossen & Kottasz, 2020; Den Ouden, 2012; Molling & Klein, 2020; Vladimirova, 2019). Based on the literature reviewed in this section, value proposition will be defined as:
All products and services that create value for the customer. Additionally, it should include the effect it has on external stakeholders, such as society and the environment.

1.3 Company Description

HighTechXL is a deep-tech venture builder located on the High Tech Campus Eindhoven in the Netherlands. It was founded in 2013 as a startup accelerator and subsequently became a venture builder in 2018. With this change, its focus shifted to building ventures in the deep-tech industry. HighTechXL aims to "build deep-tech ventures that address grand societal challenges" (HighTechXL, 2021). This used to be done in the form of a 9-month program consisting of three phases that include but are not limited to weekly meetings, lectures, coaching, office space, their network, structural funding, and deliverables. The program was started two times a year, and each start indicates a new ‘Cohort’, but this has changed, which is further explained later in this section. The program is called the ‘venture journey’ and is partially based on Bunt’s thesis (2019) and is constantly being refined and improved. While the program is continuously being enhanced, eight KPIs are forming the program’s foundation. These KPIs are Business model, Market, Product, Technology, Finance, Supply chain, Sustainability, and Team (Bunt, 2019). For each of the KPIs, a KPI owner specialized in that specific domain of knowledge, providing feedback to all of the ventures. The program director, responsible for running the program, has an overarching view of all KPIs. The program follows a stage-gate model, and a simplified visual overview of the venture-building program is provided below in figure 3.

![Figure 3: Overview of the venture-building program]

HighTechXL is located on the High Tech Campus Eindhoven (HTCE). HTCE has chosen an open innovation approach (Hutama & Putra, 2015; Chesbrough, 2003). The campus hosts 260 companies and over 12,500 employees, which share R&D facilities, knowledge, and expertise to help accelerate breakthrough innovations (High Tech Campus, 2022; Hutama Reksa Putra, 2015). HTCE is located within the Brainport region, which accounts for over 25% of national R&D expenses by industrial companies, while the region only houses 5% of the total population (CBS, 2022). In addition, the Brainport region has the highest concentration of granted patents per resident worldwide (Akhtar, 2012; Romme, 2022; Van Agtmael & Bakker, 2016).

HighTechXL uses the combination of this local ecosystem and its international network for sourcing new technology and talent as a foundation for the ventures. The technology is sourced from prominent research institutes, such as CERN, European Space Agency (ESA), TNO, Fraunhofer, Waterloo Institute for Nanotechnology (WIN), and Philips. Talent is sourced through the co-founder process, which is partly based on the thesis of Van Scheijndel (van Scheijndel, 2020). Additionally, there is also a “talent track” implemented in the venture-building program. Here talents from big corporates get the opportunity to get hands-on experience and knowledge about deep-tech startups and venture builders. For this, they support a startup of their choice on a part-time basis.

In addition, promising technologies sourced from these institutes are discussed in a so-called Fastrackathon, a reverse hackathon where experienced entrepreneurs, business
developers, physicists, finance managers, and engineers are invited. The Fastrackathon is a half-day idea session in which technologies are freely available, and teams have to complete the Market Opportunity Navigator and pitch these at the end of the event. After the Fastrackathon, additional team members are selected to further strengthen the team before starting the pre-program. The pre-program ventures participate in a selection process, after which the nine-month venture-building program is started.

The first phase focuses on developing and defining the Pitch deck, business model, target market, product Minimum Viable Product (MVP) plan, and core team development, and the teams will be prepared for XLDAY. XLDAY is an event during which the ventures can pitch their progression to the HighTechXL network, including investors, business developers, etcetera. The second phase focuses on the market and product validation, financial planning, investor deck, and refinement of the team. The third phase focuses on revenue creation, investor engagement, a business plan deck, and product launch strategy. Throughout the program, the venture teams also receive support on topics such as legal, marketing and communication, subsidies, taxes, and insurances. A more in-depth overview of how the ventures are supported is provided in sections 4.2 through 4.6.

Recently some changes have been made to the venture-building program. The program now does not use “cohorts” anymore. HighTechXL is now constantly attracting new talent and technologies that can start the program at any given point in time. In addition, the program now does not have three strict three-month phases. It was noticed that some teams and technologies required more time, and others could progress more quickly. Therefore, the program is now more tailor-made to address the needs of individual teams. Additionally, sprint weeks have been implemented. These are weeks during which most of the workshops, activities, and meetings with partners and investors are concentrated. However, except for these changes, the focus and the structure, such as the eight KPIs and the stage-gate model, remain the same.

1.4 Conclusion
The purpose of this study is to develop insights into what are helpful methods that can be implemented in a deep-tech venture-building program for communicating the value proposition of deep-tech ventures to investors. A theoretical and empirical analysis will be conducted to ensure this framework is based on evidence from scientific literature and current practice. The empirical findings could add to the existing knowledge base as little literature is available about communicating the value proposition of new ventures in the deep-tech industry to investors. Based on the theoretical and empirical analysis, design requirements and principles will be formulated in collaboration with the appropriate HighTechXL staff members to guide the development of the framework. The design principles and requirements will be the foundation for developing a framework aimed at better communicating the value proposition of deep-tech ventures to investors. This solution design can be implemented in a deep-tech venture-building program and be used by deep-tech ventures to help bridge the valley of death.
2. Methodology

2.1 Research approach

The aim of this thesis is to develop a framework providing guidance on how to communicate the value proposition of new ventures to investors within the deep-tech industry. For developing this framework, the design science approach is adopted. This is a research methodology in which both researchers and practitioners contribute to the co-development of knowledge. (Hatchuel, 2001; Holmström, Ketokivi, & Hameri, 2009; Pascal, Thomas & Romme, 2013; Romme & Endenburg, 2006; Andriessen, 2007). The design science approach integrates scientific literature in combination with empirical research and has been recommended as a means to bridge this gap between theory and practice while addressing complicated and important problems and, at the same time producing scientific knowledge (Gibbons et al., 1994; Romme, 2003). This is also the reason both theoretical and empirical analysis will be done during this research. Design science is of a more prescriptive nature (Romme & Keskin, 2020) compared to the descriptive nature of more mainstream research approaches. Design science aims to create a solution design/artifact (Van Aken, 2004) as a means to an end (Holmström et al., 2009).

This initial solution design is developed based on literature, an empirical analysis, and by the use of design principles and requirements. These formulated design principles then guide the development of a custom-made solution (Romme & Endenburg, 2006) that will be implemented, tested, and further refined through an iterative process. This testing will be done both through alpha and beta testing and will be initiated as soon as possible to maximize the iterative process. First, the initial design will undergo alpha testing to allow for rapid testing and fast iterations. These improvements will be implemented before starting the beta tests. Afterward, the feedback received during beta-testing will be implemented in the final solution design when necessary.

The first step of this research will be defining the problem. After formulating a problem statement, an initial literature review will be conducted from which the main research question and the sub-questions can be derived. The majority of the data collected during this thesis will be qualitative in nature, as this can provide a more in-depth understanding of the problem and its potential solutions. In addition, the accessible population of new ventures is limited, which also aids qualitative research. This thesis will be explorative in nature to create an evidence-based framework for communicating the value proposition of deep-tech ventures to investors. This is also better suited for qualitative research.

There are five main categories of research methods for qualitative research, which include: (1) narrative research, (2) case study research, (3) grounded theory, (4) phenomenology, and (5) participatory action research (Creswell et al., 2007). One of the methods that will be used in the thesis is case study research. Additionally, there are several effective methods for data generation, which include field notes, participant observations, interviews, diary questionnaires, and surveys (Hirsch et al., 2000; Stringer, 1999). From this, field notes, participant observations and interviews will be used in this research. First, a literature review will be conducted to formulate the design principles to ensure these are grounded in the literature (Van Aken & Romme, 2009). For the case study, several data sources that will potentially be used during this thesis will include but are not limited to: Interviews, physical artifacts, documents, and direct and participant observations. The interviews will be semi-structured, but the exact questions asked can differ due to the different responsibilities of participants within HighTechXL. For each case, the decision will be made on what form of interview and documentation of the interview will be most suitable. The participant observations will be done through fulfilling an active role related to my thesis subject within
HighTechXL. For the empirical analysis, the researcher takes on the role of both practitioner and researcher, involving the co-development of knowledge via both roles, which is a common characteristic of design science (Hatchuel, 2001; Holmström, Ketokivi, & Hameri, 2009; Pascal, Thomas & Romme, 2013; Romme & Endenburg, 2006; Andriessen, 2007).

2.2 Data collection and analysis

2.2.1 Theoretical analysis

The theoretical analysis will be used for answering sub-question one. For this, a literature review will be done. This literature review was conducted when writing the research proposal for this research. At this point in time, the research focused more on tangibles, including but not limited to the development of mock-ups, prototypes, and MVPs. Therefore, the search query and corresponding results for the literature review are focused on these topics. An overview of these concepts is provided below in table 2.

Table 2: Concepts and other related search terms for initial literature review

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Other related search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investors</td>
<td>Investor, investment, business angel, venture capital, fund*</td>
</tr>
<tr>
<td>Value proposition</td>
<td>VP, customer value proposition, CVP</td>
</tr>
<tr>
<td>Deep-tech</td>
<td>Deep-technology, high-tech</td>
</tr>
<tr>
<td>Venture builder</td>
<td>Accelerator, incubator, startup factory</td>
</tr>
<tr>
<td>Product development</td>
<td>Prototype, rapid prototyping, proof of concept, proof of principle, minimum viable product, MVP</td>
</tr>
<tr>
<td>Investor communication</td>
<td></td>
</tr>
<tr>
<td>New ventures</td>
<td>Early-stage ventures, startups, early-stage companies</td>
</tr>
</tbody>
</table>

This provided an initial set of papers to be reviewed. In addition, prior research performed within HighTechXL was included to be reviewed. After this initial selection, the snowballing principle and the reverse snowballing principle are used to find other useful literature. The snowballing principle is a valid substitute for database searches (Wohlin, 2014). In the snowballing principle, researchers will consider the cited references in the initial set of papers for inclusion and exclusion to find additional papers. In the reverse snowballing principle, researchers will consider the papers that cite the initial papers for inclusion and exclusion. Using this last method allows for discovering more recent research papers. These steps above are an iterative process and will be continuously performed throughout this thesis. During the theoretical and empirical analysis, new concepts applicable to this research question arose, which were then further examined through literature review and the (reverse) snowballing principles. Examples of these topics include terms such as sustainable value, pitching, information asymmetry, signal theory, sustainability, SDGs, impact KPIs, Theory of Change, ecosystem, and simulations. These topics are elaborated upon in chapter 3.

First, the current value proposition landscape will be mapped, including new developments in methods of developing and communicating the value proposition. This will be divided into three main categories, namely: the development and communication of value propositions through semantics, visuals, and tangibles. Finally, the characteristics for communicating the value proposition to investors will be investigated.
2.2.2 Empirical analysis

For the explorative process of answering the second sub-question regarding how venture builders’ deep-tech ventures currently deal with communicating the value proposition to investors, qualitative research methods will be used. This is because in explorative research, qualitative research methods are most suitable (Yin, 2016). This study will include teams, humans, communities, and ecosystems, and thus quantitative data will be limited. The collection of data will be done through participant observations, interviews and will also include documents available within HighTechXL. Finally, discussions with HighTechXL staff and other experts will be documented using field notes. The above-mentioned methods will serve as a way to gain insights into how new ventures and venture builders currently develop and communicate their value proposition to investors. A short overview of generated insights is provided below in table 3. A more extensive overview of the field notes is provided in Confidential Appendix B.

Table 3: Insights for empirical analysis from different methods

<table>
<thead>
<tr>
<th>Methods</th>
<th>Data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant observations</td>
<td>Participating in the weekly business 1-1s with ventures in different phases of the venture-building program and providing feedback. This provided data about the venture-building program and how it currently deals with developing and communicating value propositions, and how ventures are prepared for investor communication.</td>
</tr>
<tr>
<td>Workshops</td>
<td>Workshops provided by HighTechXL employees or external experts. The most relevant workshops included Value Proposition Canvas, customer discovery interviews, customer validation interviews, investor engagement, Theory of Change, pitching, and Market Opportunity Navigator. This provided data about the content provided in the venture-building program and how ventures are prepared for investor communication.</td>
</tr>
<tr>
<td>Simulation</td>
<td>Responsible for a successful pilot project to include simulations for performing a feasibility study to decide whether to continue with a certain technology. This provided insights about the applicability of simulations to early-stage deep-tech ventures.</td>
</tr>
<tr>
<td>Entrepreneur in residence</td>
<td>With another HighTechXL employee, I was responsible for improving the venture-building program on the KPIs of product and supply chain through the development of several templates, assignments, and a workshop.</td>
</tr>
<tr>
<td>Entrepreneur in residence</td>
<td>Participating in the weekly Entrepreneur in residence meeting during which the business 1-1s, progress, and needs of all ventures are discussed. It provided insights into how teams are evaluated, and decisions are made by the HighTechXL team.</td>
</tr>
<tr>
<td>Deep-dive sessions</td>
<td>Responsible for hosting several deep-dive sessions during which a brainstorm was performed about a technology in the pipeline for the program with (external) experts about the technology or potential markets. The Market Opportunity Navigator was the starting point for this brainstorm. It provided insights about how HighTechXL utilizes the ecosystem to create knowledge early on about potential applications and markets for a technology.</td>
</tr>
</tbody>
</table>
I attended ‘dragon den’ sessions where ventures interact with and pitch towards investors. Investors would provide feedback to the ventures about strong aspects of the venture and points to improve upon. The investors also explained what type/stage of ventures they focus on, what financing methods they provide, and what general requirements are for ventures to be eligible for investments.

Discussions with the CEO about possible directions for the thesis. Including directions such as a broader definition of value proposition, including things such as the founding team and sustainability. Also, that proper communication of the value proposition of increased importance to disruptive innovations when compared to incremental innovations as comparisons to similar products cannot be made, and therefore the value proposition should tell the whole story clearly. CEO also stated that communicating the value proposition through tangibles such as prototypes is a good method, and it could be researched what factors (ecosystem, partners, etc.) can contribute to this development.

### Interviews

Interviews were conducted with the CEO, program manager, and the Sustainability Officer, who also performed the role of Sustainability Officer for an early-stage deep-tech fund. During these interviews, topics relevant to the research question were discussed. Some of those topics were derived from the participant observations and available documents, such as the importance of sustainable impact and the Theory of Change. The interviews confirmed findings from other empirical methods. They provided deeper insights in the pain points and current methods used regarding value proposition communication, receiving investments, and communicating the sustainability aspect of a venture’s value proposition to investors.

### Documents

I had access to all relevant internal documents of HighTechXL. This provided insights into all of the templates used in the venture-building program, agreements with current partners, and the structure of the current venture-building program.

The participatory action research provided valuable insights into the current methods used by HighTechXL. In this respect, I contributed to the venture builder in several different roles. These roles include but are not limited to attending business 1-1’s to gain insights as well as provide feedback to the ventures; Attending workshops and working on the templates together with the ventures; setting up pilot projects with (potential) partners to streamline the product development for the ventures; co-developing templates to professionalize the program on three different KPI’s, Product, supply-chain and sustainability; and other activities. Being so close to the venture teams and HighTechXL staff members provided information that could not have been obtained in any other way. Many field notes were generated based on discussions with different sources, including the CEO, ex-CEO & CGO, program manager, supply chain specialist, and the Sustainability Officer. In addition, field notes were created based on discussions with staff members, external parties, and business 1-1s.
For the interviews, a semi-structured approach was used. There was a set of base questions developed to be sure to gain insights into all relevant topics. Due to the different knowledge bases, expertise, and responsibilities of each person interviewed, the focus of the interview among the base set of questions could differ. Everything was recorded and transcribed. Open-ended questions were used and provided valuable insights. Four interviews were done due to the limited population size of people having roles related to these topics within HighTechXL. After the interviews were conducted, they were all transcribed and coded to reduce bias.

The empirical analysis will be conducted at HighTechXL, a deep-tech venture located on the high-tech campus in Brainport Eindhoven. If covid allows, I will be physically present at HighTechXL from November to the final delivery date of my thesis. During this time, the venture-building program called ‘the venture journey’ will be investigated through observation, documentation, and actively participating in meetings and other important events. This will allow for a deep understanding of HighTechXL and, more specifically, the way it currently deals with communicating the value proposition to investors. After conducting the theoretical and empirical analysis, design principles will be formulated to help develop the design solution(s). This will be further elaborated upon below.

2.3 Design principles and requirements

For answering the third sub-question about building an evidence-based framework to structurally improve the communication of the value proposition to investors, the theoretical and empirical analysis will be combined to formulate the design principles. This will be done by using the CIMO logic depicted in table 4.

Table 4: Explanation of CIMO logic from Denyer et al., 2008

<table>
<thead>
<tr>
<th>Component</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context (C)</td>
<td>The surrounding (external and internal environment) factors that the nature of the human actors that influence behavioural change. They include features such as age, experience competency, organizational politics and power, etc.</td>
</tr>
<tr>
<td>Intervention (I)</td>
<td>The interventions managers have at their disposal to influence behaviour. For example, leadership style, planning and control systems, training, performance management. It is important to note that it is necessary to examine not just the nature of the intervention but also how it is implemented.</td>
</tr>
<tr>
<td>Mechanism (M)</td>
<td>The mechanism that in a certain context is triggered by the intervention.</td>
</tr>
<tr>
<td>Outcome (O)</td>
<td>The outcome of the intervention in its various aspects, such as performance improvement, cost reduction or low error rates.</td>
</tr>
</tbody>
</table>

These principles should be theoretically grounded and can be used as guidelines for developing the design solution. When creating these principles, it is essential first to understand the underlying mechanisms (Denyer et al., 2008). This is because it is crucial to understand how certain outcomes are induced by specific interventions within a particular context. The theoretical analysis will be used for developing and formulating the mechanisms and interventions. After completing the design principles, design requirements can be created. These will help in obtaining a deep understanding of how certain interventions initiate corresponding mechanisms to produce desired outcomes in a specific context to create practical relevance in addition to adding to existing knowledge (Denyer et al., 2008; Van Aken & Romme, 2009; van Burg et al., 2012).
The design requirements will be formulated based on discussions, and interviews, with the HighTechXL staff members and staff members of the new and alumni ventures of HighTechXL. This is to ensure usability and practical relevance of the solution design. Several different types of design requirements will be used, including functional requirements, user requirements, boundary conditions, and design restrictions (van Aken, Berends, & van der Bij, 2012). After formulating the final design requirements, they will be shared with HighTechXL for validation and to create awareness.

2.4 Validating and testing
Throughout the process of developing the framework, it will constantly be tested and validated through an iterative process. In the early phases of the development, the iterations will be fast and short to allow for quick and targeted improvements of the framework. Initially, the developed framework will be reviewed by experts amongst the HighTechXL staff members and possibly amongst staff members of the ventures to help finalize the framework. During beta testing, team members of different ventures in different roles will be asked to test the framework for further development.

2.4.1 Alpha testing
Based on the earlier formulated design principles and design requirements, an initial design solution will be developed. To guarantee practical relevance and required quality of the framework, an alpha test will be conducted. For this, HighTechXL staff members will be asked to inspect the initial design solution and provide feedback. This feedback will then be implemented, after which other HighTechXL staff members can be contacted to review the improved version. This ensures fast development through an iterative process in the early stages of developing the framework.

2.4.2 Beta testing
After the initial requirements of the design are met, the first solution is achieved, and HighTechXL team members are satisfied with the solution design, beta tests will be conducted. For this testing phase, team members of HighTechXL’s ventures will be contacted. Several team members will use and test the design solution and provide feedback to allow for further improvements before finalizing the design solution.

2.5 Conclusion
This thesis aims to develop an evidence-based framework for HighTechXL and its ventures to better communicate the value proposition to investors. For this, the design science approach is used. This entails a literature review to perform a theoretical analysis, after which an empirical analysis is performed. The combined analyses will guide the development of design principles and requirements, which will serve as the foundations and provide a framework for the solution design. The final solution is developed through an iterative process, including alpha and beta tests to ensure validity.
3. Theoretical analysis

3.1 Introduction
In this chapter, the aim is to answer the first sub-question and provide a clear overview of the existing methods to communicate value propositions. Sub-question 1 seeks to determine what the scientific literature states about existing methods for communicating value propositions. The research question focuses on communicating the value proposition to investors. However, before a value proposition can be communicated, it should first be developed. Therefore, this chapter not only focuses on the communication of the value proposition but also on the development of the value proposition.

To answer this sub-question, the three main categories described below—semantics, visuals, and tangibles—will be used as the structure for this chapter. While the structure semantics, visuals, and tangibles for communicating a value proposition has not been proposed in literature before, it is a structure that allows for logical categorization of the reviewed literature, and as literature from a period of over 20 years has been included, (Donaldson and Preston, 1995; Chesbrough & Rosenbloom, 2002; West et al., 2021; Portincaso et al., 2021). Therefore, it can be expected that future research can be categorized in the same manner.

The first category is value proposition communication through semantics. Earlier definitions of value proposition considered only the customer-firm relationship and focused on the products and services of value to the customer (Chesbrough & Rosenbloom, 2002; Osterwalder et al., 2014). Later, this definition was broadened, and it was proposed that a value proposition should also consider other stakeholders, such as the environment and society (Porter & Kramer, 2011; Den Ouden, 2012). This broadened definition is especially applicable to deep-tech ventures as it is associated with solving grand societal and environmental challenges (Portincaso et al., 2021). Therefore, the value created for the environment and society is essential in a deep-tech venture’s value proposition.

Additionally, deep-tech lacks an articulated narrative due to the nascent and complex nature of the products, resulting in a lack of understanding (Portincaso et al., 2021). Also, early-stage deep-tech ventures often do not yet have a product or service of value to a customer that can be used for communicating the value proposition. Therefore, other methods have to be chosen, including the usage of words. To be able to communicate the narrative of these deep-tech ventures and describe what value is provided in the future to the customer and other stakeholders, such as society and the environment, it is important what aspects of a venture are mentioned, and that appropriate words are chosen for articulating the value proposition. Osterwalder et al. (2014) describe the usage of ad-libs for this aspect of the value proposition, and two papers focusing on this aspect include those of Straker and Nusem (2019) and Straker and Wrigley (2018), which are further elaborated upon in section 3.2. For the reasons described in this and the previous paragraph Semantics is chosen as a category because it is important to know what aspects of a venture should be mentioned, and how they should be formulated when communicating its value proposition.

The second category is the communication of the value proposition through visuals. For communicating a venture’s value proposition, often visual tools are used. Examples of such tools proposed in books or scientific literature include the Value Proposition Canvas (Osterwalder et al., 2014), the value mapping tool for sustainable business models (Bocken et al., 2010), and a tool for building sustainable value propositions for multiple stakeholders (Vladimirova, 2019). Additionally, a second form for communicating the value proposition
through visuals is through simulations or digital twins. Digital twins are defined as “a dynamic virtual representation of a physical object or system across its lifecycle, using real-time data to enable understanding, learning and reasoning” (Bolton et al., 2018, p. 782). Digital twins have shown to create new possibilities for the co-creation of value propositions (West et al., 2021). Digital twins and simulations require less capital because the complex and often expensive hardware required for developing a physical product does not have to be paid for. This allows deep-tech ventures to visualize and communicate how their product will function and what performance levels will be achieved. As value propositions are often developed and communicated through visual tools, and the use of digital twins and simulations have shown to create new opportunities for value proposition communication, *visuals* is included as a form of value proposition communication.

The third category is the communication of the value proposition through *tangibles*. Within deep-tech, most products are hardware-based and are, therefore, tangible. Osterwalder et al. (2014, p. 43) describe the value proposition as "an overall view of a company's bundle of products and services that are of value to the customer" and describe prototypes and products as suitable methods for testing and communicating a value proposition. The products and services offered are always at the core of a value proposition and are, therefore, essential in communicating a value proposition. Research about factors that can contribute to accelerated deep-tech prototype and/or product development could allow deep-tech ventures to communicate their value proposition earlier through the products and services of value to a customer. Examples of such factors could include DBTL cycles and deep-tech ecosystems (Portincaso et al., 2021), which are further elaborated upon in section 3.4. As the products and services of company are always at the core of a value proposition, and most products within deep-tech are tangible, *tangibles* is included as a category for communicating the value proposition.

Section 3.2 will describe the methods described in the literature to develop and communicate the value proposition of new ventures through semantics. Section 3.3 will have the same function but will describe the methods of development and communication through visual tools, and 3.4 will do so through the tangible form. 3.5 will describe the literature about communicating a value proposition to investors and investor communication in general. Finally, a conclusion will be provided. This will offer a clear general overview of the available literature about the topic of this thesis and provide an answer to sub-question one.

### 3.2 Communicating the value proposition through semantics

As described in section 1.2.4, there are different definitions for the value proposition and what it embodies also differs per definition. A brief overview of different definitions and the evolution of what it embodies will be provided in this section. One of the more well known definitions of the value proposition is that of Osterwalder et al. (2014, p.43), who define a value proposition as "an overall view of a company's bundle of products and services that are of value to the customer." For mapping out the value proposition, Osterwalder uses the 'Value Proposition Canvas,' which will be further elaborated upon in 3.2.2. Chesbrough and Rosenbloom (2002) defined the value proposition as "the value created for users by the offering based on the technology" (p. 553). However, later on, this definition has been criticized by Gassmann et al. (2016) because the added value for customers is not solely created by the technology offerings.

Thus far, the value proposition has mainly focused on the offerings of technology, products, and services of a company. Barnes et al. (2009) later introduced the perceived costs of a value proposition. These perceived costs do not only include the monetary costs but also include the switching costs and the perceived risks of a product. Barnes et al. (2009) further
describe the perceived value as benefits minus costs, where benefits are defined as 'the outcomes and experiences of value to the client and not the features of the offering' (p. 29). This more customer-oriented focus can be noted in more academic literature. One example is the prior described Value Proposition Canvas (Osterwalder, 2014). Rintamäki et al. (2007) further elaborated upon perceived value and introduced more intangible dimensions, including ethical, emotional, economic, functional, and symbolic value.

A further extension of what the value proposition embodies was proposed by Den Ouden (2012), stating that not only an organization and its direct customers should be included, but others impacted by the value proposition, such as the climate or society, have to be included too. This and other important stakeholders are further elaborated upon by (Bocken et al., 2013) through the form of a value mapping tool for sustainable business modeling. This visual tool incorporates different stakeholders, such as the customers, environment, society, and network actors.

As seen from the above text, most literature about value proposition is about 'what' a company is doing. However, the value proposition should also incorporate 'why' a company is doing what they are doing (Straker & Nusem, 2019). This is especially true for new deep-tech ventures, as Portincaso et al. (2021) state: "Both nascent and complex, deep-tech lacks an articulated narrative and, as a result, suffers from a void of understanding or inaccurate reputation" (p. 13). In addition, new deep-tech ventures often do not have a functioning product yet.

Straker and Nusem (2019) developed an extension of 'Sinek's Golden Circle' model, a tool for analyzing and formulating from the inside-out 'why,' 'how,' and 'what' a company is doing to create value for its customers and capture a part of this for the company. Straker and Nusem (2019) show that clearly communicating the 'why' of a company can help build trust with its customers. The need for trust and being perceived as reliable and honest is especially true for companies with a social agenda (Straker & Nusem, 2019) which is true for most of the current deep-tech ventures. Clearly formulating the 'why' of a company also helps in creating the missing articulated narrative mentioned by Portincaso et al. (2021). The extension of 'Sinek's Golden Circle' is an iterative process consisting of a set of 11 questions targeted at discovering and formulating the 'what,' 'how,' and 'why' both from the company's and the customer's perspective and can be seen below in figure 4. By combining both perspectives, misalignments can be discovered, and a correct value definition can be co-developed with the customer.
For better communicating this value proposition, the authors use Straker and Wrigley’s (2018) emotion-code index. This tool is used for two main reasons, being: “(1) to understand the affective state of an organization’s value proposition and (2) to design a new value proposition which communicates the desired affective state” (Straker & Nusem, 2019, p.68). The emotion code-index incorporates seven affective states, an explanation, and words or statements a company can use to communicate this affective state and ensure alignment of the value proposition and the required articulated narrative of the company.

To conclude, a value proposition should provide an overview of the products and services that create value for the targeted customer. Additionally, it should go beyond merely the customer-firm relationship, and include other external stakeholders, such as society and the environment. Also, as deep-tech often lacks an articulated narrative, they should communicate their ‘why’, as this can help create trust. The need for trust and being perceived as reliable and honest is especially true for companies with a social agenda which is true for most of the current deep-tech ventures. Tools described in this section can be used to better articulate the ‘why’ of a company. This can help better communicate the narrative of a deep-tech venture’s value proposition.

3.3 Communicating the value proposition through visuals

Using visuals is a second form of communicating the value proposition described by Osterwalder et al. (2014). This can either be through the form of developed tools such as the Value Proposition Canvas (Osterwalder et al., 2014) or the value mapping tool (Bocken et al., 2013), or through simulations such as computational fluid dynamics (CFD) or digital twins. Most of the tools regarding value proposition are developed to simplify and improve the development of a value proposition through the form of simple-to-understand visuals. The tools often allow for fast iterations and rapid testing of different value propositions and market/customer segments. This exploration of varying market/customer segments is
especially vital for emerging technology firms (Gruber et al., 2008). These authors
discovered that exploring different market opportunities allows companies to have a choice
set of different markets prior to entering a certain market. Gruber et al. (2008) discovered a
positive relationship between the number of market opportunities and the company’s
performance using emerging technologies. A brief overview of different value proposition
tools will be provided below.

3.3.1 Value Proposition Canvas

The best-known example of communicating the value proposition through visuals is the Value
Proposition Canvas developed by Osterwalder et al. (2014), depicted below in figure 5. The
value proposition is part of the BMC, which have both become ubiquitous (Kyhnau &
Nielsen, 2015). The Value Proposition Canvas consists of two sides, 'the customer profile'
and the 'value map.' In the customer profile, a specific customer segment is described by
formulating the customer jobs, customer pains, and customer gains. Those are respectively
defined as "what customers are trying to get done in their work and their lives as expressed
in their own words; bad outcomes, risks, and obstacles related to customer jobs; the
outcomes customers want to achieve or the concrete benefits they are seeking." (Osterwalder et al., 2014, p. 37) There are three types of customer jobs, functional jobs,
social jobs, and personal/emotional jobs; three types of customer pains, undesired
outcomes, problems and characteristics, obstacles, and risks; and four types of customer
gains required gains, expected gains, desired gains, and unexpected gains. The definitions
for all of these are listed below in Appendix A, table 16. After listing all of the jobs, pains, and
gains, they should be ranked from the most essential to the least essential jobs, pains, and
interests to know which should be prioritized in the value map.

In the value map, aimed at describing how value is created for a customer, the features a
company’s value proposition consists of are defined by formulating the products and
services, gain creators, and pain relievers. Respectively they are defined as: "a list of all the
Products and Services a value proposition is built around; how your products and services
create customer gains; how your products and services alleviate customer pains." (Osterwalder et al., 2014, p. 36). There are four types of products and services
physical/tangible, intangible, digital, and financial, for which the definitions are provided
below in Appendix A, table 16. Again, the importance of all products and services, pain
relievers, and gain creators should be ranked from most essential to least essential for the
respective value proposition.
After filling out both the customer profile and the value map, the two will be compared to see whether there is a fit. This is done by comparing the corresponding topics, customer jobs vs. products and services; customer pains vs. pain relievers; and customer gains vs. gain creators. In addition, the rankings in importance for these categories in the customer profile and the value map are also compared to determine how well the most important aspects for the customer (segment) are targeted, and, thus, the level of fit.

Most literature describing the value proposition notion has focused solely on the customer-firm relationship (Vladimirova, 2019), including the example above. However, both in practice and literature, there is a demand for possibilities to include the sustainable impact of a company in the core of the company. This is especially true for deep-tech as it aims to solve grand societal and environmental issues (de la Tour et al., 2021). Several tools have been developed which aim to address sustainability within the value proposition by incorporating the environment, society, and other stakeholders. One of these tools targeted at sustainability is the Theory of Change. It is defined as the mental representations and theoretical assumptions that explain how and why activities of an initiative (e.g., projects, programs, organizations) generate particular changes (Mason & Barnes, 2007). These assumptions will later be reflected upon in combination with the changes actually made and are, therefore, also a form of knowledge production (Oberlack et al., 2019). This knowledge can then be used to alter programs/projects to decrease the gap between the targeted changes and the achieved changes. There is also an active discussion on the conceptualization of value propositions and, more recently, on sustainable value propositions (Vladimirova, 2019). However, most of these tools still lack ease of implementability by industrial users in practice (Evans et al., 2017) and/or the possibility to integrate sustainability aspects into the value proposition of a company (Vladimirova, 2019).

To conclude, the value proposition is a useful tool for value proposition development and communication, which has become ubiquitous. It aids in developing a value proposition that
solves a customer’s pain and creates customer gains for job they are performing. However, it solely focusses on the customer-firm relationship and does not consider the effects on external stakeholders, such as society and the environment. The inclusions of these stakeholders has been proposed in several papers and is especially relevant for deep-tech as it is associated with solving grand and societal challenges. Therefore, other papers addressing the integration of these stakeholders in the value proposition will be reviewed. Two papers targeting the need for integrating the environment and society into the core of a company are those of Bocken et al. (2010) and Vladimirova (2019). They have created visual tools to fulfill this task. Both of these tools will be further elaborated upon below.

3.3.2 Value mapping tool for sustainable business modeling

The first tool, developed by Bocken et al. (2010: p.1), is "a value mapping tool for sustainable business modeling". It is created to help companies balance their economic, social, and environmental value. It is a tool that reaches beyond merely economic value and includes several different stakeholders to achieve a more holistic view of the value proposition. These stakeholders are partly based on Donaldson and Preston (1995) their research about stakeholder types and were expanded during the research: customers, investors and shareholders, employees, suppliers and partners, the environment, society, academia, media, government, and external agencies. Besides incorporating other stakeholders, Bocken et al. (2010) also look more in-depth at the current value proposition and how the current value proposition destroys or misses value, as depicted below in figure 6.

![Figure 6: Opportunities for value innovation (Bocken et al., 2010, p. 488)](image-url)
By taking a more in-depth look at the value proposition, including the different stakeholders, and focusing on how value is destroyed or missed, new opportunities for value creation can arise. For example, Bocken et al. (2010) states pollution has a negative effect on the environment. By, for example, recycling part of this pollution or switching to a more environmentally friendly alternative, new opportunities for value creation are created.

Based on the inclusion of different stakeholders and a more in-depth look at the current value proposition, two value mapping tools of varying complexity were created. Both of them are shown below in figures 7 and 8. In both figures for each of the stakeholders, the current value proposition’s effect should be written down. After which, the other circles will have to be filled out, as depicted in figure 7. Figure 8 was later developed as a simplification to make it more suitable for workshops.

To conclude, the tool of Bocken et al. (2010) addresses the need for incorporating other stakeholders, such as society and the environment in the value proposition. Additionally, it not only considers where value is captured but also negative value creation and new opportunities for value creation. However, the tool is mainly applicable to the ideation and analysis stages. Therefore, an additional tool addressing addresses the need for incorporating other stakeholders, such as society and the environment in the value proposition will be reviewed.

![Figure 7: Value mapping tool (Bocken et al., 2010, p. 490)](image-url)
3.3.3 Building sustainable value propositions for multiple stakeholders

Another tool aimed at building sustainable value propositions is that of Vladimirova (2019). It is a tool based on multiple literature streams, combining the concepts of value proposition (Osterwalder et al., 2014), sustainable value (Yang et al., 2014), sustainable business models (Bocken et al., 2013), and mutuality of stakeholders in a broader network including society and environment (Haigh & Griffiths, 2009). The tool is designed utilizing engaged scholarship, a form of PAR, and went through several iterations before achieving the final result.

The final design incorporates different stakeholders, and for each stakeholder, the economic, social, and environmental value have to be defined. **Economic value** is described as "Economic value forms could include cost savings, profit, return on investment and long-term viability" (Vladimirova, 2019, p.3). **Social value** is described as: "Social value forms refer to the benefits created for various members/groups in society and could include job creation, secure livelihoods, health, wellbeing and community development" (Vladimirova, 2019, p.3). **Environmental value** is described as: "Environmental value forms refer to reducing negative impacts, e.g., resource efficiency and pollution prevention of air, water, and soil, as well as creating positive impacts for the environment, e.g., investing in renewable resources" (Vladimirova, 2019, p.3).

The model is also based on stakeholder mutuality, where reciprocity is expected between all actors. Each stakeholder that reaps benefits from the value proposition should bear responsibility for and contribute to value creation in the system (Frow et al., 2014). In addition, the environment and society are treated as primary stakeholders of the company, resulting in greater sustainable value creation. This results in the tool depicted below in figure 9 and the corresponding 5-step process to complete the tool. The tool is developed to be used in workshops and provides a structured step-by-step procedure for creating a value
The main steps that have to be taken are:

• Step 1: Define the unit of analysis - a new value opportunity, e.g., product, service, project, idea, technology, which could lead to a change in the existing business model or to the creation of a new business model.

• Step 2: Identify key stakeholders of the new value opportunity, i.e. stakeholders who can enable or prevent successful change, which might include specific customers, decision-makers, partners, suppliers, representatives of society, proxies for the natural environment.

• Step 3: Describe the economic, social and environmental benefits of the new value opportunity for each of the stakeholders.

• Step 4: Describe the contributions from each stakeholder for the realisation of the new value opportunity.

• Step 5: Develop a sustainable value proposition for each stakeholder." (Vladimirova, 2019, p.5).

To conclude, the tool of Vladimirova (2019) addresses the need for incorporating other stakeholders, such as society and the environment in the value proposition. It describes what value is created for each stakeholder and that each stakeholder should create value in the system. By considering society and the environment as primary stakeholders, the value proposition will become more sustainable and contribute to a more sustainable business model. However, it does not include SDG contribution, while this is an important framework often used by deep-tech investors, as described in section 3.5 and 3.5.1. Additionally, it takes less of a customer-perspective when compared to the Value Proposition canvas, as it does not consider the pains and gains a customer experiences when performing a job. Therefore, this tool alone does not allow for proper identification of customer needs and effective communication of the value proposition to deep-tech investors.

3.3.4 Simulations

Osterwalder et al. (2014) describe ten prototyping principles essential for exploring different value propositions. Three of these are "Make it visual and tangible", "Start with low fidelity, iterate, and refine", "learn faster by failing early, often, and cheaply". All three of these are good principles when designing most types of products. In deep-tech, however, development
costs and times are very high. The prototypes of deep-tech products and systems are already based on complex systems, requiring high skill levels and significant capital. It is not unusual for deep-tech startups to take over a year to build a functional prototype, thus making it difficult to fail early, often, and cheaply. However, current developments in AI, simulation software, and the constant increase in computing power allow for accurate digital representations of complex systems. This increase allows for more rapid and affordable methods of developing and testing (digital) prototypes. The current developments in virtual reality (VR) combined with new interface devices that allow for proper motion tracking allow a tangible experience to be created using a digital prototype in a virtual environment (Tseng et al., 1998). This improved technology allows for immersive digital prototypes, which is important for interacting with, and testing of the prototypes.

In addition to this, the increases in computing power allow predictions to be made about a product's behavior and the corresponding manufacturing processes and production planning to evaluate different prototypes. Process and activity modeling are at the core of functional virtual prototypes to support manufacturing simulation. These process models represent the entire range of physical processes necessary for a product's behavior and manufacturing processes. The activity models incorporate the different engineering activities required for the management of the production and engineering of the product (Kimura, 1993). Examples of such simulation methods include, for example, CFD to test, among others, the aerodynamic properties of a product; Methods to test the behavior and functional requirements of application-specific integrated circuits (APIC). Another method is finite element analysis (FEA) to predict how a product reacts to vibrations, fluid flow, heat, direct forces, and other physical effects and whether a product will fracture, wear out or behave within the constraints of the design requirements. Overall, simulations could help reduce development times and associated costs within deep-tech through, for example, but not limited to, the development of digital prototypes and digital twins.

To conclude, the complex nature of deep-tech products results in long-development times and high development costs before a functioning prototype is developed. This makes it difficult to fail early, often and cheaply. However, decreasing costs and increasing access to computing power allows deep-tech ventures to develop and test digital prototypes, which are also known as digital twins. Digital twins have shown to create new possibilities for the co-creation of value propositions and require less capital because the complex and often expensive hardware required for developing a physical product does not have to be paid for. Therefore, simulations could be a valuable form of communicating the value proposition of deep-tech ventures through visuals.

3.4 Communicating the value proposition through tangibles
A third form of communicating the value proposition is through tangibles. This can range from low-fidelity mock-ups up to a fully functioning product manufactured for large-scale production. Recent research has shown that focusing on developing prototypes early on is one of the main contributing factors for achieving successful product development (Camburn et al., 2017). Osterwalder et al. (2014, p.76) define prototyping as “the practice of building quick, inexpensive, and rough study models to learn about the desirability, feasibility, and viability of alternative value propositions and business models.” Prototyping can help in exploring different value propositions quickly and identifying the bottlenecks within product development. Starting with the prototyping in the early stages in cooperation with other important stakeholders increases the likelihood of successful business model innovation while simultaneously de-risking the overall process (Brown & Eisenhardt, 1995).
This is especially important and challenging for ventures operating within deep-tech because deep-tech requires high levels of skill, large investments, and long-development times (Harlé et al., 2017; Portincaso et al., 2021; Priego et al., 2021), thus making it difficult to quickly and inexpensively develop different models. Osterwalder et al. (2014) state that it is important to start with low-cost, low-fidelity prototypes, learn from them, and incorporate these learnings into a more refined prototype. This rapid iterative process allows ventures to discover errors early on in the process and thus fail and learn quickly and cheaply. Osterwalder et al. (2014) uses the Design, Test, Evolve cycle for this process. A similar approach is proposed by de la Tour et al. (2021) through the form of the DBTL cycle, a process explicitly proposed for deep-tech ventures. DBTL cycles help in accelerating breakthrough solutions for big societal and environmental problems. I will outline each step of this cycle below.

The *design* phase is at the foundation of the innovation process. In this phase, most of the value is created. The decreased barriers to accessing high technology and the increased availability of information have advanced collaboration and open innovation (de la Tour et al., 2021). These collaborations are essential for accelerating deep-tech innovation as it requires different stakeholders to interact and co-develop technologies due to the complex hardware-based and capital-intensive innovations related to deep-tech (Portincaso et al., 2019). The *build and test* phase is where the development of the products and/or prototypes happens. Here again, the actors within the ecosystem are important, as these allow small ventures to scale up and access things that are too challenging to develop in-house due to their high costs or lengthy development times (de la Tour et al., 2021). The *learn* stage, as the name implies, is where the learning takes place. The increased access to and lower prices of things such as IoT sensors and AI help speed up this process. They help generate and process data at an increased rate and feedback loops allow for rapid iterations and improvements to the developed products.

As mentioned above several times, ecosystems are essential to deep-tech innovations. This is underpinned by Portincaso et al., who dedicated their whole report to this topic. In their report, the authors describe four traits of deep-tech ecosystems. These are “more types of players from diverse sources, highly dynamic, less reliance on a central orchestrator and more on multifaceted interactions among participants and, money not the only means of exchange” (Portincaso et al., 2019, p. 26). The more types of participants described are a total of seven participants. These are, in no specific order: Universities and research centers, Governments, corporations, startups, investors, users, and facilitators. The interactions between all of those participants are depicted in figure 10 below.
One type of player not depicted explicitly in figure 10 but mentioned in the literature is a maker space. A maker space is a shared facility with machines and equipment to develop demonstrators, prototypes, and products. The machines are often too expensive to afford for a startup, but by using a shared facility, they gain access to otherwise inaccessible equipment for a limited fee (Steiber & Alänge, 2020). Osterwalder and Pigneur (2014) use the term prototyping space and describe it as a space to quickly develop and test new value propositions. Steiber and Alänge (2020) describe it in their research about corporate-startup co-creation to increase innovation and societal changes. It is described as a facility where co-design and co-development can happen, and demonstrators and prototypes can be developed in a very short period.

3.5 Communication to investors

Financial resources are essential for a company’s survival, growth and development. These financial resources are often secured by obtaining external investments (Kollmann & Kuckertz, 2006). This is especially true for early-stage ventures as they usually do not generate profit yet. In addition, the early stages of deep-tech ventures are very capital-intensive when compared to, for example, SaaS. This is due to the long time to market and highly complex hardware-based solutions requiring major investments in both human and financial resources (Romme, 2022). These factors described above make attracting financial resources also more challenging as the uncertainty about the future ROI is exceptionally high (Kollman & Kuckertz, 2006).

Plenty of literature is available about investor relations (Hoffmann et al., 2018; Huang & Knight, 2017; Kollmann & Kuckertz, 2006). However, most of this literature is about corporate-investor relations, and there is little literature available about early-stage ventures and even less about deep-tech ventures. Due to the circumstances described in the paragraph above, the process for attracting investors is fundamentally different for corporates and early-stage (deep-tech) ventures and can be more difficult for early-stage (deep-tech) ventures. One crucial aspect causing this difficulty is the information asymmetry between companies and potential external investors (Audretsch et al., 2012). Information asymmetry refers to a situation where one party possesses more knowledge about the subject than the other party (Bloomenthal, 2022a). In the case of this thesis, it would refer to a venture team having more knowledge about the venture than the investor has. This
information asymmetry especially applies to early-stage innovative new ventures (Blumberg 
& Letterie, 2008), as (co-)founders possess more information about the competencies of the 
company and the usage of potential investments. In addition, as these ventures are still 
(very) early-stage, the required information can be challenging to gather or does not (yet) 
exist at all (Mason & Stark, 2004). Examples are a lack of a product prototype, a Minimum 
Viable Product (MVP), market traction, profit, and/or revenues. The assets these new 
ventures do possess are often intangible and knowledge-based, making it harder for external 
investors to directly observe the quality of a venture (Audretsch et al., 2012). This intangible 
knowledge thus again increases the information asymmetry between both parties.

A literature stream discussing investor communication of (early-stage) ventures is that of 
signaling theory (Audretsch et al., 2012; Becker-Blease & Sohl, 2015; Huang & Knight, 2017; 
Ibrahim, 2009). The theory is about sending (positive) signals to external parties to decrease 
information asymmetry. This decrease in information asymmetry can potentially lead to an 
increase in the likelihood of receiving investments from an external investor. Several studies 
have been conducted about what signals can lead to an increase in the probability of 
receiving investments from external investors and an increase in the valuation of new 
ventures. Entrepreneurs aim to attract investors' attention through two types of signals. 
Audretsch, Bönite, and Mahagaonkar (2012) refer to these types as appropriability and 
feasibility signals in their research about financial signaling by innovative nascent ventures. 
A venture, especially an early-stage one, by definition, has more information about the 
potential returns of investments on its intangible assets than an external investor (Carpenter 
& Petersen, 2002). This causes an information asymmetry between the venture and the 
investor. Particularly for very early-stage ventures, this information asymmetry is likely to 
cause significant problems (Audretsch et al., 2012), including moral hazard problems, 
difficulties in attracting external investments, or unattractive financial conditions (Carpenter 
& Petersen, 2002). Audretsch et al. (2012) have found that combining multiple signals can 
have a greater effect than the sum of its individuals. Therefore, it can be assumed that by 
sending as many signals as possible, this information asymmetry will be decreased, and the 
investor will be provided with more knowledge about the venture. This will likely reduce the 
number of problems faced and increase the likelihood of investment.

A signal that has been proven to improve the likelihood of receiving investments is patents. 
Patents increase the likelihood of acquiring external investments, as shown by the research 
of Engel and Keilbach (2007). They discovered that companies with a higher number of 
patent applications have a greater likelihood of obtaining investments. The study of Hellman 
and Puri (2000) showed similar results and that innovating companies are more likely to 
attract funding than imitating companies. In addition, the research of Hsu and Ziedonis 
(2008) showed that patents increase the valuation of a startup, specifically in the earlier 
financing rounds. However, solely possessing patents is sometimes not enough to obtain 
external investments (Gompers & Lerner, 2001). It increases in value when mixed with other 
factors, such as the knowledge of the entrepreneur about the technology.

The appropriability signal sent by a patent might also increase in value when combined with 
a signal of feasibility (Audretsch et al., 2012). Combining different signals is, therefore, an 
important aspect of signaling theory. An example of such a feasibility signal for early-stage 
ventures is a prototype. By providing a working prototype, the feasibility of the project is 
shown. It signals, among others, manufacturing ability and cost strategy (Audretsch et al., 
2012). This allows an investor to increase their level of assessment of the early-stage 
ventures and could therefore make the valuation and financing easier (Audretsch et al., 
2012). Other examples of potential signals are provided below in table 5.
### Table 5: Signals to communicate to investors

<table>
<thead>
<tr>
<th>Signal</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior successful startup founding experience</td>
<td>(Hsu, 2007)</td>
</tr>
<tr>
<td>Educational background</td>
<td>(Hsu, 2007)</td>
</tr>
<tr>
<td>Potential for scalability with high imitation barriers</td>
<td>(Block et al., 2019)</td>
</tr>
<tr>
<td>Located in a startup ecosystem</td>
<td>(Grilo et al., 2018)</td>
</tr>
<tr>
<td>Top management legitimacy</td>
<td>(Baum &amp; Silverman, 2004; Chen et al., 2009; Fisher et al., 2018; Murnieks et al., 2011; Shane &amp; Stuart, 2002)</td>
</tr>
<tr>
<td>Third-party endorsements</td>
<td>(Courtney et al., 2016; Plummer et al., 2015; Stuart et al., 1999)</td>
</tr>
<tr>
<td>Being fair</td>
<td>(Shepherd &amp; Zacha, 2010; Tuominen, 1997)</td>
</tr>
<tr>
<td>Consistency and commitment</td>
<td>(Shepherd &amp; Zacha, 2010; Tuominen, 1997)</td>
</tr>
<tr>
<td>A proper business plan</td>
<td>(Audretsch et al., 2012)</td>
</tr>
<tr>
<td>International links</td>
<td>(Audretsch et al., 2012)</td>
</tr>
<tr>
<td>Team composition</td>
<td>(Audretsch et al., 2012)</td>
</tr>
</tbody>
</table>

Several of these signals are very applicable to deep-tech venture builders. Deep-tech technologies are based on patents, and the goal for a deep-tech venture builder is to develop technologies starting from TRL 4 (Romme, 2020). The innovations go through a thorough selection process and are therefore often scalable, and due to their complexity, high costs, and IP Protection, their imitation barriers are very high (de la Tour et al., 2021). In addition, venture builders source all of the potential co-founders themselves, so can consider prior successful startup founding experience, educational background and team composition.

Another aspect of a venture’s value proposition is the impact they aim to make. The rising importance of a venture’s impact among investors can be denoted by the increase in the total value of impact investments over the last year. This number increased from 16 billion euros in 2020 to 39 billion euros in 2022 (Dealroom, 2021). In addition, the Sustainable Finance Disclosure Regulation (SFDR) was introduced in 2021, which is a “European regulation introduced to improve transparency in the market for sustainable investment products, to prevent greenwashing and to increase transparency around sustainability claims made by financial market participants” (Eurosif, 2022). This shows that impact is of increasing importance not only on an investor level but also on a policy level. Two frameworks often used by investors related to impact, SDGs and Theory of Change will be discussed below.

#### 3.5.1 Sustainable Development Goals

A framework often used by investors and deep-tech startups are the SDGs developed by the United Nations with the objective “to transform our world and to improve people’s live and prosperity on a healthy planet” (United Nations, 2019). The SDGs were developed in 2012 at the United Nations conference on sustainable development (Enelamericas.com, 2022), where member states, the UN system, and civil society organizations met to develop the 2030 agenda (Feminist Alliance for rights, 2022). The SDGs have been signed by stakeholders all around the globe. There are 17 objectives for the SDGs, which are:
No poverty, Zero Hunger, Good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace justice and strong institutions, and partnerships for the goals (United Nations, 2019). These 17 objectives have a total of 169 sub-targets. These objectives and sub-targets were officially initiated on January 1, 2016 (Zielinski et al., 2018) and will run until 2030. The predecessors of the SDGs were called the Millennium development goals, which were active from 2000 until 2015. These goals mainly focused on developing countries, whereas the SDGs address all countries without considering economical development (European Political Strategy Centre, 2019). Another differentiation is that businesses did not incorporate the MDGs as they were focused on developing countries, whereas the SDGs are important for every company in their sustainable development (PWC, 2015). The SDGs are not legally binding, but help governments set agendas to ensure the involvement of different important stakeholders (Chicksen et al., 2018). The SDGs also serve as guidance for companies to increase their positive impact and decrease their negative impact on society and the environment. (SDG Compass, 2015). These SDGs can help ventures and investors align on what aspects a venture wants to focus. Therefore, SDGs should be included when early-stage deep-tech ventures communicate with investors.

3.5.2 Theory of Change

Another framework often used by impact investors is the Theory of Change (Jackson, 2013). A Theory of Change helps turn the desired impact into concrete actions. Oberlack et al. (2019, p. 1) Define the Theory of Change as the mental representations and theoretical assumptions that explain how and why activities of an initiative (e.g., projects, programs, organizations) generate particular changes, which was based on the research of Mason and Barnes (2007). These assumptions will later be reflected upon in combination with the changes made and are, therefore, also a form of knowledge production (Oberlack et al., 2019). This knowledge can then be used to alter programs/projects to decrease the gap between the targeted and achieved changes. The Theory of Change originates from the 1990s and was initially used by social programs to evaluate their impact (Bickman, 1987; Weiss, 1997). It is now widely implemented among social organizations, such as NGOs. However, its use is still rare within universities and research institutes (Paina et al., 2017).

There are several different methods for developing a Theory of Change. One thing they all have in common are the main building blocks. These are impact, outcome, enablers, output, activities, and input (Harries et al., 2014). Throughout the development, the required evidence and made assumptions should be written down. When developing a Theory of Change, the desired impact or end goal must be formulated first. From there, the organization moves backward to define the required conditions to achieve this end goal. Moving further backward will result in the activities and input a company has to deliver to achieve the desired impact. This process is outlined below in figure 11. A more extensive guide for developing a Theory of Change can be found in section 6.4 of this thesis.

![Figure 11: Overview of the theory of change](image-url)
3.6 Conclusion

The conclusion derived from the theoretical analysis will provide an answer to the first sub-question. It will serve as an overview of the methods of communicating the value proposition and its communication to investors. Later on, it will function as input for developing the design principles, which will guide the development of the design solution. The following conclusions can be drawn from this chapter to answer sub-question one summarizing what the scientific literature states about existing methods to develop and communicate value propositions.

**Communicating the value proposition through semantics.** A well-known definition for value proposition is "an overall view of a company's bundle of products and services that are of value to the customer." (Osterwalder & Pigneur, 2014, p.43). However, this definition only entails the customer-firm relationship. Afterward, this definition of what a value proposition embodied was broadened, and things such as perceived costs and risks were introduced (Barnes et al., 2009). Later, it was proposed that a value proposition should incorporate other important stakeholders as well and not only consider the customer-firm relationship (Bocken et al., 2013). Examples of such stakeholders include society, the environment, and network actors. The inclusion of the stakeholders society, and the environment applies very well to deep-tech ventures as deep-tech aims to solve grand-societal and environmental challenges (Portincaso et al., 2021). For better developing and communicating the purpose behind a value proposition, Straker and Nusem’s (2019) model could be used. It focuses on developing not only ‘what’ a company is doing but also ‘why’ and ‘how’ a company is doing by using Sinek’s golden circle model. For better articulating the narrative behind a value proposition, the authors use Straker an Wrigley’s (2018) emotion code index used for communicating the correct affective state. Properly communicating this narrative is important for deep-tech ventures as those often miss an articulated narrative (Portincaso et al., 2021).

**Communicating the value proposition through visuals.** In regard to visual tools for developing a value proposition, three tools were described. The Value Proposition Canvas Osterwalder et al. (2014) developed is the most well-known. However, this tool only focuses on the customer-firm relationship. Several other tools, including those of Bocken et al. (2013) and Yang et al. (2017), introduced other stakeholders, such as society and the environment, to include sustainable value into the value proposition and obtain a more holistic view of a value proposition. However, these tools mainly apply to the ideation and analysis stage instead of allowing for the development and (effective) communication of sustainable value propositions, making it difficult to implement them in the deep-tech industry (cf. Vladimirova, 2019). Vladimirova’s tool (2019) aims to increase applicability in later stages. However, it does not allow deep-tech ventures to address SDG reporting and developing a Theory of Change. Both are frameworks often required for proper communication with deep-tech and/or funds. Therefore, these tools can still be improved to apply to deep-tech ventures.

Simulations were shown to be applicable to deep-tech ventures due to the high costs and long development times associated with deep-tech. The current developments in AI, simulation software, and increased computing power, while having lower costs allow for accurate digital representations of complex systems and provide startups easier access to these resources. This allows for the creation of digital prototypes, or digital twins. Finally, several examples of simulation methods applicable to deep-tech were provided.

**Communicating the value proposition through tangibles.** A third form of communicating the value proposition is through the form of tangibles. Examples of tangibles include mock-ups, prototypes, and products. Having developed a prototype is a valuable method for communicating the value proposition, as it is one of the signals described in section 3.5.
Having a prototype early on is one of the main contributing factors for achieving successful product development (Camburn et al., 2017). However, deep-tech is associated with high development costs and long development times, making it challenging to quickly and cheaply iterate on several prototypes. To accelerate the development of products within deep-tech, partners should be included (Portincaso et al., 2019; cf. Brown & Eisenhardt, 1995), and DBTL cycles should be implemented (Portincas et al., 2021). The description for each of these phases is provided in section 3.4, but they help in accelerating breakthrough solutions for big societal and environmental problems. Ecosystems are essential for deep-tech product development due to the complex hardware-based products. Portincaso et al. (2019) describe four traits of a well-functioning deep-tech ecosystem. In addition, the required actors and the interactions among them have been described. Finally, a valuable addition to the ecosystem described would be a makerspace (Alänge, 2020; Osterwalder & Pigneur, 2014), where ventures have access to shared equipment too expensive to purchase themselves. Overall, deep-tech ventures should start developing prototypes as soon as possible while using the proposed DBTL cycles. In addition, they should learn how to build and navigate a proper deep-tech ecosystem and utilize all other stakeholders to their full potential.

Communicating to investors. Financial resources are essential for a company’s survival, growth, and development and are often external investments (Kollmann & Kuckertz, 2006). This is especially true for early-stage deep-tech ventures as they have a long and expensive valley of death due to a product’s long development times and high development costs. This can make attracting funding challenging due to the high uncertainty about the ROI (Kollmann & Kuckertz, 2006). A literature stream relevant to (early-stage) ventures is signaling theory (Huang & knight, 2017; Audretsch et al., 2012). Here the goal is to decrease the information asymmetry between a venture and investor by sending as many relevant signals as possible, as it can cause significant problems (Carpenter & Petersen, 2002). An overview of relevant signals is provided in section 3.5. An additional signal relevant for deep-tech/impact investors is the impact they intend to make. Impact investing also increased from 16 billion in 2020 to 39 billion euros in 2021 (Dealroom, 2021) Ventures operating within the EU are now also obliged to report on this due to the SFDR. Frameworks often used by investors to report sustainability are the SDGs and the Theory of Change.

To provide an answer to sub-question one about what scientific literature states about existing methods to develop value propositions and communicate them to investors. The value proposition should not only focus on the customer-firm relationship but should include the effect it has on external stakeholders, such as society and the environment. This helps in better articulating the narrative, which deep-tech ventures often lack. Visuals tools shown to be a valuable form of developing and communicating the value proposition and some have become ubiquitous. Simulations are applicable to deep-tech as they allow for the development of virtual prototypes without the significant costs required for purchasing hardware. Products, which in deep-tech are often tangible, are at the core of a value proposition. For successful deep-tech product development, makerspaces, DBTL cycles and a well-functioning deep-tech ecosystem where all actors contribute in multiple ways are proposed. Attracting investments is especially difficult for early-stage deep-tech ventures due to the large information asymmetry, partly caused by the lack of a developed prototype and/or product. Signal theory can be utilized to decrease this information asymmetry. Most deep-tech investors also focus on impact and impact investments are rapidly increasing. Two frameworks often used by investors regarding impact are the SDGs and the theory of change. Additionally, deep-tech is associated with solving grand societal and environmental challenges. Therefore, when early-stage deep-tech ventures communicate their value
proposition to investors they should include the effect it has on society and environment. To optimize communication of the value proposition, they should use language generally understood by investors, by for example including the SDGs and a theory of change. However, no frameworks are available that allow for the integration of the SDGs and Theory of Change in the value proposition. Therefore, a framework could still be developed the fulfills this purpose.
4. Empirical analysis

4.1 Introduction
This chapter will describe the empirical analysis performed. It will describe how HighTechXL supports the ventures in developing their value propositions and how to prepare for investor communication. In this chapter, sub-question two will thus be answered, which seeks to determine how HighTechXL’s ventures currently develop their value proposition and communicate it to investors.

All data was gathered at HighTechXL, from ventures that are currently in, or went through, its venture-building program, and at an early-stage fund well-connected to HighTechXL. The findings from this chapter will be compared to those from the theoretical analysis performed in chapter three to highlight the differences and similarities between the literature and current practice at HighTechXL. The structure of semantics, visuals, and tangibles as methods for communicating the value proposition will again be used.

4.2 Venture-building program
A short summary of the venture-building program, as described in 1.3, is provided here. Figure 12 provides a visual overview and is described in this section. The venture-building program follows a stage-gate model. Before the program starts, the HighTechXL staff is responsible for Scouting and Assessing new technologies to enter the program. There are specific requirements for a technology to enter the program, such as the TRL and the potential impact. Simultaneously other HighTechXL staff members are responsible for the talent acquisition for people to enter the program. After several technologies and talents have been selected, the pre-program starts. This is where the development of the value propositions starts. During the pre-program, the talents may divide themselves into groups, choose a technology, and at the end of the pre-program, pitch their most important findings to HighTechXL and its alliance members. The alliance members are part of the Eindhoven Startup Alliance, which supports HighTechXL. The Eindhoven Startup alliance is founded by ASML, Philips, BOM, High Tech Campus, HighTechXL, ABN-AMRO, EY, NTS-Group, and HVG with the mission to “turn Eindhoven into THE high tech startup capital of the world” (Eindhoven Startup Alliance, 2022). The end of the pre-program is the first gate, and at this moment, the teams either start the venture-building program or are not allowed to enter the program with the current combination of team, tech, and/or application areas. After entering the program, the value proposition development continues through an iterative process during all program phases. An overview of different tools and methods used throughout the program will be provided in this chapter using the same division as in the theoretical analysis, semantics, visuals, and tangibles.
4.3 Semantics

During the pre-program, the teams are required to clearly understand the problem they are solving and the customers for whom they are doing this. This is to better perceive the problems a customer experiences and ensure the value proposition addresses them. For this, several workshops and tools are implemented into the pre-program, including the Market Opportunity Navigator, which I will get into later, and a workshop about customer discovery interviews. Another aspect focused on is sustainability, through a workshop provided by the Sustainability Officer focusing on the mission & vision of a venture. This mission & vision, as well as the value proposition, always needs to be linked to the SDGs to create awareness of the potential impact from the beginning. In addition, the focus is also on building a diverse, well-balanced team of co-founders with relevant experience. These four focus points above, problem statement, customer validation, team, and sustainability, can later help build and sharpen the value proposition.

This integration of the SDGs demonstrates that the value proposition is broadened within HighTechXL, compared to the definition of the value proposition by Osterwalder et al. (2014, p.3): "an overall view of a company's bundle of products and services that are of value to the customer." HighTechXL incorporates sustainability, which is also confirmed by the program manager, stating that "for developing the value proposition, we say, for example, it should be linked to the SDGs" (Confidential Appendix A, interviewee 1, p. 6). Besides sustainability, HighTechXL also considers the founding team to be an essential part of a startup. The CEO of HighTechXL confirmed this: "One thing I have not mentioned yet, which of course is absolutely part of that value proposition, is the composition of the team" (Confidential Appendix A, interviewee 2, p. 9). While team composition is not part of venture’s value proposition, the CEO states the team is perhaps the most important part of a startup: it should be a passionate, well-balanced, and trustworthy team to be able to convince investors to provide funding. Additionally, having a team member that has a high skill level for pitching can help in better communicating the value proposition to investors through semantics.

For communicating the value proposition through semantics, HighTechXL has implemented several things aimed at pitching. It has a dedicated person who has been a keynote speaker, presenter, and pitching coach for over ten years, with a lot of experience in pitching deep-tech value propositions combined with knowledge about creative storytelling. He helps all the ventures prepare their pitches for different types of public. For this, two specific workshops are implemented, ‘storytelling’ and ‘life’s a pitch’. The public for which ventures have to pitch can range from one to two investors to several hundreds of people on XLDAY. The training incorporates what (body) language to use, how to address people, and many other things. Besides the dedicated pitch coaching, two documents are used to help aid the development of the pitches: one was developed in-house, and the other externally.

The external tool is the pitch canvas (Beckett, 2022), consisting of 9 building blocks. These are Pain (+Gain), Product, Product Demo, What’s Unique, Customer Traction, Business Model, Investment, Team, and an End statement with a call to action. For all of these building blocks, there are trigger questions to help develop the perfect pitch. In addition, the canvas states the pitch should always start with a simple statement of what impact ventures are making.

In addition to this canvas, HighTechXL has developed a pitch toolbox internally. It is a 35-slide document that expands upon the building blocks from the pitch canvas described above. It consists of lists of do’s and don’ts for developing the script, the slide deck and
presenting, links to example pitches created using this tool, and other things that cannot be discussed in this thesis due to confidentiality.

To conclude, HighTechXL has a well-developed toolset focusing on different aspects of value proposition communication through semantics. This includes, but is not limited to, pitch training from an experienced pitching coach, several pitch templates, and several workshops. Additionally, where the current academic literature described in sections 1.2.4 and 3.2 observes a demand for a broadened definition of what a value proposition embodies, HighTechXL has already implemented such an extended definition. This definition already includes things such as sustainability, SDGs and the team in the value proposition from a very early-stage. Overall, HighTechXL has already implemented the changes proposed in literature in practice and provides a professional set of tools, workshops, and templates for its ventures to communicate the value proposition. Therefore, shortcomings described in the literature are not discovered in practice, and no additional changes have to be made.

4.4 Visuals

Many visual tools related to value proposition development and communication are used throughout the program. The first tool is the Market Opportunity Navigator, briefly mentioned above. This tool was developed by Gruber and Tal (2017) in their book “Where to Play.” It was based on studies by Gruber, Macmillan, and Thompson (2008, 2012) about how the identification of different market opportunities before market entry positively affects firm performance. The Market Opportunity Navigator is a visual tool consisting of three steps. The first step is to list a venture’s core abilities and identify a set of market opportunities consisting of an application and a specific customer. The second step is to evaluate the attractiveness of the different market opportunities. For this, their potential and their associated challenges are reviewed. For this, several characteristics are considered, depicted below in figure 13. After considering all characteristics, there will be an overall value for potential and challenge, which will be mapped in the market attractiveness map.

The market attractiveness map has an x- and y-axis forming four quadrants. The y-axis indicates the overall potential of a market opportunity, and the x-axis shows the market opportunity's overall challenge. The upper-left quadrants are the gold mines, the upper-right are the moon shots, the bottom-left are the quick wins, and the bottom-right are the questionable market opportunities. For deep-tech, most opportunities should be in the upper-right quadrant, as deep-tech is associated with high funding requirements, long development times, and focused on yet-to-be-developed markets (Portincaso et al., 2021), thus resulting in a high overall challenge. If a high degree of challenges is faced, the potential should be similarly high to prevent focusing on questionable market opportunities. After filling out all of the market opportunities, there is a clear overview of all quadrants. The third and final step is determining what opportunity to pursue first. For this, the agile focus dartboard is used, which helps in deciding which option to pursue right now, what options to keep open and what options to place in storage for now.
A second template related to value proposition development used in the program is the Value Proposition Canvas developed by Osterwalder and Pigneur (2014). This canvas is used in combination with the Business Model Canvas (Osterwalder & Pigneur, 2010). The Value Proposition Canvas is explained in detail in section 3.3.1, so it will not be further elaborated upon below. HighTechXL is working on an improved Value Proposition Canvas with a partner to help incorporate other aspects into the canvas (Confidential Appendix A, interviewee 1, p. 2). This shows there is also demand for innovation regarding the value proposition in practice and not only in literature.

Another workshop, more closely related to the sustainability part of a venture’s value proposition, is the Theory of Change workshop. It explains the Theory of Change and how a Theory of Change should be developed and ends by challenging the ventures to develop their Theory of Change. The workshop is developed and given by HighTechXL’s Sustainability Officer. It is relevant because there is an increasing number of VCs and funds that have started to use the Theory of Change, such as DeepTechXL, ShiftInvest, and StartGreen Capital (Confidential Appendix B, p. 30; StartGreen Capital, 2022).

Another form for testing and developing value propositions used within HighTechXL’s ventures is simulations. For this, HighTechXL has partners able of performing simulations in different domains. This can be used in different stages of value proposition development. It has been used to perform rapid feasibility studies to decide whether to continue with a specific technology, but it can also be used to gain insights into potential future performance products.

Finally, the final resource used to communicate value propositions and help with storytelling is through videos and animations. There are two dedicated persons within HighTechXL responsible for making these videos and animations. The animations are mainly used to help explain the often complex technologies of the different ventures, as “If you want to explain complex things, a simple animation can help out a lot” (Confidential Appendix A, interviewee 2, p. 10). These animations are thus focused more solely on the technology offerings of a venture. Videos are used to provide a broader sense of a venture’s value proposition. These
videos often consist of most of the nine building blocks described in the pitch canvas and are combined with video to provide a clear overview of what a company does.

4.5 Tangibles
For developing the tangible side of the value proposition, there are also different workshops, templates, and partners, which all help in building a first demonstrator, prototype, MVP, or product. This section will described different templates and workshops included in the venture-building program, the possibilities for a makerspace, the deep-tech ecosystem around HighTechXL and how it is utilized.

Due to the complex nature and long development times of deep-tech, it is crucial to make sure all efforts of a venture are in the right direction and that the minimal requirements for a product to be of value to customers are known. For this, the MVP specs template is integrated into the program, forcing the teams to develop their requirements and methods for testing these requirements. These requirements can be set for the product overall but must also be set for essential (sub-)units.

Later on, in the venture-building program, this template will be elaborated upon by developing the product architecture, for which a separate template is developed. This will show how all components interact with, interface with, and are located in relation to each other. Ultimately it should include everything from modules and cable management to software and data management. All of these templates are critically reviewed by either the KPI owners or an entrepreneur in residence with relevant experience.

After developing the proper product architecture, a supply chain analysis will be done. For this, there is a workshop that HighTechXL’s supply chain specialist gives. This workshop discusses how to assess the risks and potential impacts of disruptions in the supply chain and how to alter it correspondingly. In the end, teams are provided the task of developing and assessing their own supply chain through the form of several in-house developed templates. The supply chain specialist again assesses these.

The most room for improvement within HighTechXL is in actually helping ventures with their hands-on product development because there is only office space and not something like a makerspace (Confidential Appendix A, interviewee 1, P. 3). Due to the complex equipment required for deep-tech product development, in combination with the different industries in which the ventures operate, it would be very expensive to build a makerspace satisfying everyone’s needs. This capital is currently not available within HighTechXL and discussions with the start-up officer of the Eindhoven Municipality indicated that the available subsidies were already awarded to another party. There is an excellent example of one accelerator/venture builder located in Belgium who provides lab supplies and equipment to the ventures. This example is J-labs, a part of Johnson & Johnson innovation and focuses solely on MedTech and healthcare innovations. Because J-labs operates within one industry and is backed by a multi-billion corporate, it is possible to provide such a makerspace.

For helping the ventures with product development, HighTechXL does have a network of different partners with a range of expertise required for deep-tech. It can be too expensive for early-stage ventures to have all the required knowledge in-house; this is where the partner network of HighTechXL is of added value. Ventures can tap into the knowledge base of these partners, often for a reduced fee, to speed up product development. Examples of knowledge domains include, among others, IoT, MEMS, PCB, precision equipment development, feasibility studies, and ISO certificates. These partners can help design the first prototype, prepare a small series production, and later help prepare the product and supply chain for scaling-up the production.
Portincaso et al. (2019) identified seven actors required to develop a proper deep-tech ecosystem. Below I will provide examples of all of these actors operating within the Brainport deep-tech ecosystem. Good examples for universities and research centers would be the Eindhoven University of Technology and TNO, as both generate IP, and there are also examples of employees or students joining a startup. Governments could be the government, the Eindhoven municipality, the BOM, and the RVO. These organizations all help in providing funding for research or building the proper fiscal and legal environment to accelerate innovation. Examples of Corporations differ significantly due to the diverse nature of deep-tech ventures, but examples could be Philips, KPN, and many others. The Startups would include all of HighTechXL’s ventures and the many other startups located on the HTCE or the Brainport Industries Campus. Examples of investors would be DeepTechXL, InvestNL, and the BOM, as they help provide cash, business guidance, and their network. It could be argued that HighTechXL is also an Investor as they provide these three things. HighTechXL would also fulfill the role of Facilitator as they provide their local and international connections, provide mentoring through the venture-building program and facilities through office space, and if possible, also lab space. A visual overview is provided below in figure 14. The ecosystem also shows the four traits of a deep-tech ecosystem, as provided by Portincaso et al. (2019).

Figure 14: Summarized overview of Brainport deep-tech ecosystem. Lay-out from Portincaso et al. (2019, p.26)

To conclude, HighTechXL has three KPIs in the program that focus on the development of the technology, product and the required supply chain. These are filled with a range of templates, assignments and workshops and two of them have recently been updated and improved by the supply chain specialist and me. HighTechXL has a diverse network of partners that can contribute to the development of tangibles and the Brainport deep-tech ecosystem has been briefly summarized. Lots of improvement could be made in the venture building program of HighTechXL by adding a facility filled with relevant equipment, where the new deep-tech ventures could develop their prototypes and/products, such as a makerspace. There are examples of venture builders that provide a makerspace, however these often only focus on one industry. Therefore, they require a less diverse set of equipment, which lowers the costs. As HighTechXL’s ventures operate in a broad range of industries and are based on various types of technologies, a diverse set of specialized equipment would have to be provided to create value for all ventures. This would require significant investments, which currently cannot be made by HighTechXL and for which no
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subsidies are available within the Eindhoven Municipality. Therefore, even though such a makerspace could create significant value for HighTechXL and its ventures, at this point in time it is not feasible.

4.6 Communicating to investors

Several practices are implemented in HighTechXL’s program to optimize the value proposition communication to investors, addressing both what has to be communicated and how it should be communicated. When communicating to investors, it is essential that the value created for customers and other stakeholders, such as society and the environment, is captured clearly and unambiguously in the value proposition. This has to be done in a way that allows investors to understand the technology and the value proposition, even when they lack in-house expertise (Portincaso et al., 2021). As early-stage deep-tech ventures often still have to develop their products, this value proposition cannot be delivered yet. The product development of deep-tech products is associated with long development times and high development costs due to the complex hardware-based nature requiring high levels of skill (Portincaso et al., 2021). Additionally, the market risks of deep-tech are high when compared to Biotech (Portincaso et al., 2021). The combination of this market risk, with the development times and costs within deep-tech, creates a high uncertainty about ROI (Kollmann & Kuckertz, 2006).

Because of the absence of a developed product, the investor should not only believe that the value proposition can create value for the customer and other stakeholders but should also have faith in the venture team to be able to develop the products and services that are at the core of delivering the value proposition. Therefore, especially for early-stage ventures without a developed product, it is essential to create the trust of a potential investor in the venture team. This is confirmed by the CEO, who stated that it is important to emphasize the team (Confidential Appendix B, p. 28; Confidential Appendix A, interviewee 2, p. 9). This trust can be difficult to create due to the large information asymmetry between investors and companies associated with early-stage ventures (Blumberg & Letterie, 2008). This information asymmetry can be caused because the required information is difficult to gather or does not yet exist (Mason & Stark, 2004), and most information available is often intangible or knowledge-based (Audretsch et al., 2012). To decrease the information asymmetry and potentially increase an investor’s trust in the ability to create and deliver the communicated value proposition, signal theory can be applied. An overview of relevant signals is provided in section 3.5, and later in this section, it will be discussed how these signals apply to HighTechXL’s ventures. Because early-stage deep-tech ventures often still have to develop the products that are at the core of the value proposition, other aspects of the venture are of increased importance, and ventures should communicate more than only what value is created for customers and other stakeholders from their value proposition. This is to decrease the information asymmetry and create trust of the investor in the venture. Therefore, it is relevant for this thesis to also discuss communication to investors in general.

Some of the practices for optimizing investor communication within HighTechXL have already been mentioned, such as the pitch training, the different workshops, templates, and tools. Other aspects have not been mentioned, such as a workshop about investor engagement providing information about how to find the right investor, how to develop a proper investor deck, and other things. Within HighTechXL, there is also a person responsible for designing these investor decks in combination with company branding. To support the development of the investor deck, there are also several workshops about finance and how to build financial planning.
An overview of different signals that can be sent to investors that have proven to decrease the information asymmetry between ventures and (potential) investors is provided below in table 6, and it is described how HighTechXL’s ventures send most of these signals.

Table 6: Signals to communicate to investors

<table>
<thead>
<tr>
<th>Signal</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patents</td>
<td>(Engel &amp; Keilbach, 2007; Gompers &amp; Lerner, 2001; Hsu &amp; Ziedonis, 2017)</td>
</tr>
<tr>
<td>Working prototype</td>
<td>(Audretsch et al., 2012)</td>
</tr>
<tr>
<td>Prior successful startup founding experience</td>
<td>(Hsu, 2007)</td>
</tr>
<tr>
<td>Educational background</td>
<td>(Hsu, 2007)</td>
</tr>
<tr>
<td>Potential for scalability with high imitation barriers</td>
<td>(Block et al., 2019)</td>
</tr>
<tr>
<td>Located in a startup ecosystem</td>
<td>(Grilo et al., 2018)</td>
</tr>
<tr>
<td>Top management legitimacy</td>
<td>(Baum &amp; Silverman, 2004; Chen et al., 2009; Fisher et al., 2018; Murnieks et al., 2011; Shane &amp; Stuart, 2002)</td>
</tr>
<tr>
<td>Third-party endorsements</td>
<td>(Courtney et al., 2016; Plummer et al., 2015; Stuart et al., 1999)</td>
</tr>
<tr>
<td>Being fair</td>
<td>(Shepherd &amp; Zacha, 2010; Tuominen, 1997)</td>
</tr>
<tr>
<td>Consistency and commitment</td>
<td>(Shepherd &amp; Zacha, 2010; Tuominen, 1997)</td>
</tr>
<tr>
<td>A proper business plan</td>
<td>(Audretsch et al., 2012)</td>
</tr>
<tr>
<td>International links</td>
<td>(Audretsch et al., 2012)</td>
</tr>
<tr>
<td>Team composition</td>
<td>(Audretsch et al., 2012)</td>
</tr>
</tbody>
</table>

HighTechXL’s ventures are most of the time based on patented technology, preferably from TRL 4 and above. In addition, in the early stages, IPR strategies are developed together with a partner to increase the imitation barriers. Also, the ventures are always guided to focus on markets with a high total addressable market, serviceable available market, serviceable obtainable market, and compound annual growth rate, or for simplicity, big and growing markets, to ensure the potential for market scalability and, thus, a potential to generate significant impact. Additionally, technologies go through a strict screening process to, amongst others, ensure value can be created for the environment and/or society, and the technology will not be the bottleneck regarding scalability. This combination of patent protection, IPR strategy, market focus, and the strict technology screening process sends one of the above signals, potential for scalability with high imitation barriers. The signal of being located in a startup ecosystem and having international links is always sent since all ventures start on the HTCE and HighTechXL has international connections in at least three continents. Then there are six signals related to the team, Prior successful startup experience, educational background, top management legitimacy, being fair, and consistency and commitment. The first four are focused on within the program of HighTechXL as they aim to develop balanced teams of 2-3 co-founders with relevant experience. However, this is not 100% under the control of HighTechXL as they depend upon the attracted talent pool, but HighTechXL is the final decision maker for whether teams can enter the program, so they can control the quality of teams entering the program. Additionally, HighTechXL has employed a team dynamics coach to determine what talent is needed for teams that have entered the program and a recruiter to attract this talent to optimize the possibility of these signals being sent. The latter two signals of being fair and
consistently committed are also focused on within the program. Due to the high intensity of the program, the critically reviewed deliverables, and the thorough business 1-1’s, being fair and being consistently committed is required to get through the venture-building program. However, these signals are again not 100% under the control of HighTechXL, as HighTechXL cannot fully control how the fairness and commitment of a venture team. During the program, the team also gets a workshop regarding customer validation to help send the signal of third-party endorsements. Finally, there is the signal of having a proper business plan. This is a huge focus point within the venture-building program, which uses the BMC as a basis for developing the business plan. The business plan is constantly being reviewed and improved by the venture, the program manager, and several industry experts. One signal that is not always sent by the ventures is that of a working prototype. However, in the venture-building program, 3 KPIs, product, technology, and supply chain focus on developing a working prototype and/or MVP and the required supply chain. This is also focused on in the weekly business 1-1s, and the partner network is utilized for the development.

For direct investor communication, HighTechXL has implemented several things. These include but are not limited to guiding the development of one-pagers, pitch decks, investor decks, and pitches of different lengths. In addition, HighTechXL also facilitates sessions with investors, such as dragon dens, and regular informal discussions with investors. This is done as early as possible to let the ventures learn from this and get accustomed to pitching in front of investors.

The increase in impact investments described in section 3.5 can also be seen in practice. “The big difference in the positive sense is that you can make a lot more impact with a deep-tech startup. And that does represent a shift that you see now that people are moving away from just making money, and there is more room to make impact” (Confidential Appendix A, Interviewee 1, p.4). Despite this, it remains difficult to attract funding as a deep-tech startup as they are associated with long development times and high development costs. This is confirmed by the program manager “Especially time to market. That is a very big one that is also linked 1-to-1 with technical complexity. From a much earlier time of such a company, the capital requirement of such a company (deep-tech) is just very much greater (Confidential Appendix A, Interviewee 1, p. 4). There is little literature available about what signals to send specifically to impact investors, but there are funds that are, for example, only focused on female founders or diversity or that pick two to three SDGs and only invest in ventures focusing on those SDGs. There are several frameworks for developing (sustainable) value propositions, but so far, non have targeted integrating the SDGs into the core of the value proposition. Reasons for this could include that SDGs are less relevant in other industries or that other frameworks for developing (sustainable) value propositions did not focus on deep-tech investor communication, as SDGs are a framework often used by deep-tech investors.

In addition, I reviewed three Final Investment Recommendations (FIRs) from a deep-tech-focused investment fund. These FIRs discuss several aspects of the venture that correspond roughly to the signals described above and the focus points from the venture-building program. One of the seven topics in the FIR is the impact a venture aims to make. Again, the SDGs and their corresponding targets are used as an important tool. In addition to this, there are also venture-specific impact KPIs developed. These impact KPIs are based upon the Theory of Change and help venture and investor align on targets and how to measure the desired impact. However, there was no literature found about developing impact KPIs. The literature available about impact KPIs focused on the impact of a failure of the application architecture, so it did not include any impact on external stakeholders.
The Sustainability Officer, who also fulfilled the role of Sustainability Officer at an early-stage deep-tech fund, confirmed the need for venture-specific impact KPIs and that investors still struggled with this topic. “We chose it also because I did research, on what do investors do. In recent years they have also been looking for how to capture the impact in objectives, which is also very important for investors. And that turns out to be quite difficult, also because it differs per startup. I call those venture-specific KPIs because they all solve something different (Confidential Appendix A, Interviewee 3, p. 19).” The Sustainability Officer confirmed this lack of literature and an established method for developing impact KPIs. I said, “Those impact KPIs are also very important. I've been searching quite a bit for what are the methods to do that. Actually, there aren't any (Confidential Appendix A, Interviewee 3, p. 21).” To which the Sustainability Officer responded, “No, that is right (Confidential Appendix A, Interviewee 3, p. 21).” The CEO also stated “We are in the process of introducing a new metrics around sustainability in general, impact, that has to be the right metrics. That is still a struggle to be quite honest” (Confidential Appendix A, Interviewee 2, p.12). The combination of these FIRs and the interview with the Sustainability Officer and CEO show that developing venture-specific impact KPIs is an important topic for investors they struggle with and that no established method has been developed. The Sustainability Officer also stated that for developing venture-specific impact KPIs, a solid Theory of Change is required. For this, internal and externally developed guides are available.

4.7 Conclusion

The empirical analysis answered the second sub-question about how HighTechXL’s ventures currently develop their value propositions and communicate them to investors. Three semi-structured interviews were conducted with HighTechXL staff members in different roles relevant to this topic and combined with findings from documents, informal discussions, and participant observations. First, a summary of the venture-building program was provided, after which it was discussed how HighTechXL included the three categories of value proposition development and communication semantics, visuals, and tangibles in the venture-building program. Finally, the current methods and struggles for communicating the value proposition to investors were discussed. To answer, the second sub-question HighTechXL has already adopted a broader definition of the value proposition proposed in the literature and includes things such as the team and sustainability. In addition, the value proposition of ventures should be linked to the SDGs. However, no formal framework is implemented for this within HighTechXL. The development of the semantic side and its communication to investors is already of a very high level within HighTechXL. It focusses on what should be communicated, and how it should be communicated. An overview of tools and methods used for developing the semantic side of a value proposition is provided an section 4.3. For the development of the semantic aspect of a value proposition HighTechXL also provides help from specialized employees or external experts and regular informal meetings with investors to get accustomed to pitching in front of investors. No significant requirements for improvement for the semantic side of the value proposition have been identified in the empirical analysis.

HighTechXL has included several visual tools for value proposition development and communication that correspond with the literature. Examples include the Market Opportunity Navigator, Value Proposition Canvas, and the Theory of Change. Explanations for these tools and how they are implemented in the program are provided in section 4.4. In addition, HighTechXL has implemented simulations in the venture-building program to allow for, amongst other rapid feasibility tests. Moreover, HighTechXL uses videos and animations to help better communicate the value proposition. HighTechXL also requires its ventures to link
their value proposition to the SDGs. The SDGs are also a framework often used by deep-tech investors and SDG contribution represents a significant part of the FIRs. However, no formal framework is implemented that allows ventures to integrate the SDGs and the effect their value proposition has on society and the environment.

To support the development of the tangible aspect of a value proposition HighTechXL has implemented a set of tools, templates, and workshops for which an overview is provided in section 4.5. In addition, HighTechXL has a product & supply chain expert providing feedback on all of these deliverables. However, HighTechXL does not provide a place with equipment where all venture teams can develop and test their products. Due to the broad range of technologies the ventures develop, this is also difficult and expensive to implement. The required capital for this is currently not available within HighTechXL or the Eindhoven Municipality. Therefore, at this point in time developing such a makerspace is unfeasible. To provide support on actual product development, HighTechXL does have an extensive network of partners capable of providing support on many different expertise areas. Finally, a part of the deep-tech ecosystem of the Brainport region has been mapped in section 4.5.

Regarding investor communication, HighTechXL has implemented a set of templates, deliverables, workshops, and meetings to support the development of a value proposition and its communication to investors. For all signals derived from the theoretical analysis in section 3.5, it is discussed how HighTechXL supports its ventures to be able to send these signals. An overview of this is provided in section 4.6. Additionally, HighTechXL provides regular direct, sometimes informal, access to relevant investors. The most challenging aspect of raising capital for deep-tech ventures is the long and deep valley of death. This is caused by the long development times and the high development costs of deep-tech products. However, within HighTechXL, the trend of increasing impact investments and generating value for society and the environment besides generating profit is also noticed.

The reviewed FIRs and the interviews showed that impact and/or deep-tech investors value the sustainability aspect of a venture as important. The findings show that these investors require SDG reporting and venture-specific impact KPIs based on a solid Theory of Change. There is no established method for integrating these SDGs into the value proposition and developing impact KPIs. In addition, the Sustainability Officer stated developing these venture-specific impact KPIs is still a struggle.

Overall, there is room for improvement in the visual and tangible side of value proposition development and its communication to investors. For the tangible side of the value proposition the biggest improvement can be made by providing a facility where the ventures can test and develop their products and/or prototypes. However, due to the significant capital required for developing such a makerspace that is currently not available, such a makerspace is unfeasible. For the visual side of the value proposition and its communication to investors there is also room for improvement. Deep-tech investors require ventures to integrate SDG contributions in their communication and venture-specific impact KPIs that are based on a theory of change. Additionally, HighTechXL requires its ventures to link their value proposition to the SDGs. Both for integrating SDG contribution in the value proposition and formulating venture-specific impact KPIs no formal framework has been developed. Developing a framework that would allow this, would create significant value for HTXL and its ventures.
5. Design principles and requirements

5.1 Introduction

This chapter will discuss the developed design principles and requirements. These will serve as input for developing the final solution design and are, therefore, a critical phase in a thesis using the design science approach. Theoretical and empirical findings have been presented in chapters three and four and will help in the development of the design principles and requirements. After formulating the design principles and requirements, an answer can be provided to sub-question three about how HighTechXL can design and implement an evidence-based framework that structurally improves the communication of the value proposition to investors. Afterward, it is explained why the choice was made to focus on developing a visual tool, based on sections 3.2, 3.3, 3.4, 4.3, 4.4, and 4.5 on semantics, visuals, and tangibles. Finally, a concluding section is provided.

5.2 Design principles

In this chapter, a set of design principles based on the CIMO format is developed and elaborated upon. The CIMO format describes how in a certain Context (C), an Intervention (I) can be made to invoke a specific Mechanism (M) to deliver a desired Outcome (O), as explained in Table 4 in Chapter two. The design principles are based on the performed theoretical and empirical analysis and will guide the development of the final design solution. An overview of the different design principles is provided below.

The theoretical and empirical analysis showed that it is essential to incorporate sustainability into the core of a venture. There is an increasing importance of sustainability both to customers (Bunt, 2019) and investors. When implementing it into the core of the business, it can be utilized as a business asset and provide a competitive advantage (Kumar et al., 2012). In the past, the alliance members of HighTechXL have also expressed the importance of contributing to the environment and society (Bunt, 2019). To address this requirement, the value propositions should be linked to at least one of the SDGs (Bunt, 2019; Confidential Appendix A, Interviewee 1, p. 6). Design principle 1 was adapted from the thesis of Bunt (2019), who based it on the research of Figge et al. (2002) and Kumar et al. (2012), as it is still very applicable to this research. One adaptation made to the design principle is changing the context from ‘high-tech’ to ‘deep-tech’, as HighTechXL currently only focusses on deep-tech. The design principle focused on using sustainability as a business asset still remains valid, as deep-tech is associated with solving grand societal and environmental challenges (Portincaso et al., 2021).

Table 7: Design principle 1 - Sustainability as a business asset

<table>
<thead>
<tr>
<th>C</th>
<th>When developing a startup in the deep-tech industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>sustainability should be considered as a business asset</td>
</tr>
<tr>
<td>M</td>
<td>to meet customer demand and differentiate the startup from competitors</td>
</tr>
<tr>
<td>O</td>
<td>allowing for additional investments/subsidies, and a long-term competitive advantage</td>
</tr>
</tbody>
</table>
The two design principles below are based on the literature described in section 3.2. Design principle 2 is based on the value proposition definition of Osterwalder & Pigneur (2014) and their Value Proposition Canvas, which is also applied in practice by HighTechXL and its ventures. The Value Proposition Canvas is integrated into the intervention, and Osterwalder et al. (2014) their definition of value proposition into the mechanism. Design principle 3 is based on the other literature (Bocken et al., 2013; Bucknell Bossen & Kottasz, 2020; Den Ouden, 2012; Molling & Klein, 2020; Vladimirova, 2019) describing the need to incorporate other stakeholders, such as the environment and society, into the value proposition.

Table 8: Design principle 2 - Value delivery to customers

<table>
<thead>
<tr>
<th>C</th>
<th>When developing a value proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The new venture should gain insights into the customers’ pains, gains and jobs</td>
</tr>
<tr>
<td>M</td>
<td>To provide an overall view of a venture’s bundle of products and services that are of value to the customer</td>
</tr>
<tr>
<td>O</td>
<td>To ensure optimal value delivery to the venture’s customers</td>
</tr>
</tbody>
</table>

Table 9: Design principle 3 - Value delivery to other stakeholders

<table>
<thead>
<tr>
<th>C</th>
<th>When developing a value proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The new venture should also incorporate other stakeholders such as the environment &amp; society</td>
</tr>
<tr>
<td>M</td>
<td>To gain insights in the impact the value proposition has on environment &amp; society</td>
</tr>
<tr>
<td>O</td>
<td>To ensure optimal value delivery to other stakeholders such as the environment &amp; society</td>
</tr>
</tbody>
</table>

Design principle 4 is based on section 3.5, the interviews with interviewees 1 and 3 (Confidential Appendix A), and FIRs received from an early-stage deep-tech fund. Interviewees 1 and 3 (Confidential Appendix A) described the relevance of linking the value proposition to the SDGs. All of the above sources described the usage of the SDGs by investors. Additionally, the theoretical analysis section 3.5 showed that SDGs are a framework often used by investors.

Table 10: Design principle 4 - Value proposition impact communication

<table>
<thead>
<tr>
<th>C</th>
<th>When developing the sustainability aspect of the value proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>It should be linked to the SDGs</td>
</tr>
<tr>
<td>M</td>
<td>To use frameworks generally understood by customers and investors</td>
</tr>
<tr>
<td>O</td>
<td>Allowing for proper communication of the value proposition’s impact</td>
</tr>
</tbody>
</table>

Design principle 5 is based on the three FIRs received from an early-stage deep-tech fund and the interviews with interviewees 2 and 3 (Confidential Appendix A). All three of the FIRs incorporated the impact KPIs as a major part of sustainability reporting required for a startup. Interviewees 2 and 3 (Confidential Appendix A) confirmed the importance of those impact KPIs.

Table 11: Design principle 5 - KPIs for investor communication

<table>
<thead>
<tr>
<th>C</th>
<th>When communicating the sustainability aspect of the value proposition to investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The venture should incorporate impact KPIs based on its Theory of Change</td>
</tr>
<tr>
<td>M</td>
<td>To adhere to the investor’s requirements</td>
</tr>
<tr>
<td>O</td>
<td>Increasing the likelihood of receiving an investment</td>
</tr>
</tbody>
</table>
Design principle 6 is based on the signaling theory described in section 3.5. A venture inherently knows more about itself than an investor does. This causes an information asymmetry which can cause significant problems for early-stage ventures. This information asymmetry is minimized by sending as many relevant signals as possible. An overview of relevant signals can be found in section 3.5.

Table 12: Design principle 6 - Decreasing information asymmetry

<table>
<thead>
<tr>
<th>C</th>
<th>When communicating a value proposition to investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>As many relevant signals as possible should be sent</td>
</tr>
<tr>
<td>M</td>
<td>To decrease the information asymmetry</td>
</tr>
<tr>
<td>O</td>
<td>Increasing the likelihood of receiving an investment</td>
</tr>
</tbody>
</table>

5.3 Design requirements
The design requirements help in ensuring the practical relevance of the design solution. The design principles are more related to the content of the solution design, whereas the design requirements are targeted more toward boundaries and limitations (Van Aken et al., 2012). There are three types of design requirements, which are functional requirements, user requirements, and boundary conditions. All of them are provided in the section below and reviewed by HighTechXL.

5.3.1 Functional requirements
The functional requirements form the foundation of the requirements. They entail the necessary performance of the final design solution.

- The design solution should link the value proposition of a venture to the SDGs.
- The design solution should aid in communicating the SDG impact of a venture to investors.
- The design solution should be evidence-based and help better communicate (part of) the value proposition to investors.

5.3.2 User requirements
The user requirements are there to fulfill the needs of the end-users.

- The design solution should be easy to use for venture teams and HighTechXL employees.
- The design solution should be easy to implement within the existing set of tools, templates, and workshops by HighTechXL.

5.3.3 Boundary conditions
Finally, there are boundary conditions. These are the conditions that must be achieved unconditionally.

- The framework must adhere to the current venture-building process of HighTechXL
- The framework must focus on developing and communicating the value proposition of new deep-tech ventures to investors.

5.4 Reasoning behind choosing the solution design direction
The theoretical and empirical analysis were very broad to ensure a thorough overview of all aspects related to the development and communication of a value proposition available within the academic literature and HighTechXL would be provided. For the final solution design, a more limited scope had to be chosen. The reasons for choosing this specific scope will be outlined below.
5.4.1 Semantics
The development and communication of a value proposition’s semantic side is already very high within HighTechXL. They have several workshops, including pitch training, mission & vision, and the pitches used to be practiced weekly during the business one-on-ones. Additionally, an experienced person is dedicated to developing and optimizing the context and delivery of the pitches. There are also internally and externally developed tools available to support the development of the pitches. There is also plenty of literature available about pitching, pitching to investors, and analyses have been performed about programs such as dragons’ den (Balakhonskaya & Balakhonsky, 2021; Daly & Davy, 2016).

Moreover, pitches for deep-tech ventures should consist of the same main building blocks as pitches for startups from different industries. These building blocks are outlined in section 4.3. Where deep-tech ventures differ from other industries is that extra focus should be on the impact they intend to make, as deep-tech is associated with solving grand societal and environment challenges (Portincaso et al., 2021). This should be linked to the SDGs, as deep-tech investors often use this framework. However, no tool exists for developing the sustainable aspect of a value proposition and linking it to the SDGs. To allow proper communication of the impact, first, a tool should be available for developing the sustainability aspect of a venture’s value proposition. Due to the above reasons and the fact that no significant requirements for improvement have been identified, the choice was made not to focus on the semantic side of value proposition development and communication.

5.4.2 Tangibles
Deep-tech has a long and deep valley of death due to the long development times and high development costs for an initial product (Portincaso et al., 2021). In this period, it is most difficult to raise investments as it requires significant capital while the ROI is still highly uncertain. The sweet spot for early-stage deep-tech venture capital funds is often around TRL 8 or 9 (Mittelmeijer, 2020), while most technologies entering the venture-building program are at TRL 4 or below. In addition, technologies and teams entering the program have not raised external capital yet. Additionally, for developing a deep-tech prototype and/or product that can be used for value proposition communication, significant capital is required. This is something new deep-tech ventures, especially ventures starting the venture building program, often do not have access to. Therefore, by developing a framework targeted at accelerating product development, most ventures in the venture building program can not directly capture value from it. Additionally, the technology portfolio of HighTechXL, despite all being deep-tech, is very diverse. It includes, amongst others, advanced materials, integrated photonics, and hydrogen production. Developing a framework that would be of added value to all types of technologies in HighTechXL’s portfolio would be very challenging, due to the diverse nature of the technologies and the industries in which the ventures operate. Developing a framework for one specific venture would make the generalizability very low, resulting in limited added value to literature and practice.

Successful deep-tech ventures also require a well-functioning deep-tech ecosystem (Portincaso et al., 2019). However, several studies have already been conducted about the characteristics of such ecosystems in general (Portincaso et al., 2019) or the Brainport deep-tech ecosystem specifically (Romme, 2022; Smits, 2022). Therefore, the added value to the existing literature could be limited. Additionally, HighTechXL and its ventures already participate in a well-functioning ecosystem in which the value of all actors is appropriately utilized. A brief overview of this ecosystem is provided in section 4.5. Therefore, the added value in practice would also be discussable.
One aspect described in the literature not yet integrated into the venture-building program of HighTechXL is a makerspace (Osterwalder and Pigneur, 2014; Steiber and Alänge, 2020). HighTechXL is aware of this potential added value as the program manager describes the lack of a makerspace as one of the main pain points currently experienced (Confidential Appendix A, Interviewee 1, p.3). However, developing a deep-tech makerspace that is of added value to all ventures would require significant equipment and real estate investments that cannot be made at this point in time. Additionally, building such a makerspace, ordering equipment, and testing its effectiveness would likely not be feasible within the limited time period available for this study. Due to the reasons described above, the choice was made not to focus on the tangible side of value proposition development and communication.

5.4.3 Visuals

Currently, visual tools are often proposed in the literature for value proposition design (Bocken et al., 2013; Osterwalder et al., 2014; Vladimirova, 2019). Additionally, visual tools are also used in practice by the ventures of HighTechXL, as shown in the empirical analysis. The use of visual tools not only targets value proposition development and communication but also other aspects of business development, including, but not limited to, the Business Model Canvas (Osterwalder & Pigneur, 2010), the Market Opportunity Navigator (Gruber & Tal, 2017), the Pitch Canvas (Beckett, 2022), and the Theory of Change. These tools have been shown to have high generalizability as they are used by companies in a range of different industries, and some are taught in education.

Both literature and practice emphasized the importance of incorporating other stakeholders, such as society and the environment, in the value proposition (Bocken et al., 2013; Den Ouden, 2012; Vladimirova, 2019). The theoretical and empirical analysis also showed that it is important to include SDG contributions of the value proposition when communicating to investors. Additionally, linking the value proposition to the SDGs is a requirement for all ventures of HighTechXL. While visual tools targeted at integrating other stakeholders, such as society and the environment, do exist, they mainly apply to the ideation and analysis stages (Vladimirova, 2019). Additionally, no tools are available for integrating SDG contribution in the value proposition, which, as mentioned before, is a requirement for ventures of HighTechXL (Confidential Appendix A, Interviewee 1, p. 6.).

Also, SDGs are a framework often used by investors, especially impact investors, which most deep-tech investors are. SDG contribution was also discussed in all three FIRs, making it an important aspect for final decision making by deep-tech investors. Thus, including SDG contributions and the created value for society and the environment would allow ventures to better communicate their value proposition to investors. Another prevalent aspect in the FIRs were the venture-specific impact KPIs, based on a theory of change. The theory of change turns desired impact into concrete actions to be taken by the venture and shows how the desired impact will be achieved. These venture-specific impact KPIs allow the venture and investors to monitor the progress on contributions to society and the environment. The CEO of HighTechXL and the Sustainability Officer, who also performed the role of Sustainability Officer at an early-stage deep-tech fund indicated that developing the venture-specific impact KPIs is still experienced as a struggle and no formal method has been established yet. Therefore, a framework that addresses the development of those venture-specific impact KPIs, based on the theory of change, would allow ventures to communicate not only what SDG impact they want to make, but also how they want to make it, and how to monitor the progress toward achieving the impact. This would allow ventures to more effectively communicate their value proposition to investors.
As described in the first three paragraphs of this section, there are also relevant possibilities for improvement for the visual aspect of value proposition development and communication. The ventures of HighTechXL are required to link their value proposition to the SDGs, for which no formal framework has been developed. Incorporating the effect a value proposition has on society and the environment is also emphasized in the scientific literature (Bocken et al., 2013; Den Ouden, 2012; Vladimirova, 2019; Porter & Kramer, 2011). The theoretical and empirical analysis also showed that SDGs are a framework often used by deep-tech investors. Therefore, integrating SDG contribution in the value proposition could allow for more effective communication of the value proposition to investors. The FIRs and a discussion with the managing partner of an early-stage deep-tech fund also showed that venture-specific impact KPIs are important for deep-tech investors. The empirical analysis showed that this is experienced as a struggle and no established method has been developed. Developing such as method could create value for HighTechXL, its ventures, and investors.

Therefore, it would be logical to develop a design solution that includes other stakeholders, such as society and the environment, and SDG contribution in the value proposition. As visuals tools are often currently used for the development of value propositions in literature and practice, and they have shown to have high generalizability, it would be logical to develop a visual tool that allows for better communication of the impact a value proposition has on the society and the environment and how it contributes to the SDGs. Additionally, to allow for effective investor communication of new deep-tech ventures the framework should also address the development of venture-specific impact KPIs.

5.5 Conclusion
The above-formulated design principles can help develop a design solution to help answer sub-question three about how HighTechXL can design and implement an evidence-based framework that structurally improves the communication of the value proposition to investors.

The framework should thus help in communicating the venture’s value proposition to investors. The theoretical and empirical analyses were very broad to ensure a thorough overview of all aspects related to the development and communication of a value proposition available within the academic literature, and HighTechXL would be provided. For the final solution design, a more limited scope had to be chosen. The reasons for choosing this specific scope are described in section 5.4. As described in section 5.4.1 the semantic side of the value proposition is already of a very high level within HighTechXL, and no significant requirements for improvement have been identified. Regarding the tangible side of the value proposition there was still room for improvement within HighTechXL, as described in section 5.4.2. The program manager indicated that one of the biggest pain points currently experienced is the lack of a makerspace, a facility filled with shared equipment where the ventures can test and develop their prototypes. However, that would require significant capital which is currently not available within HighTechXL or the Eindhoven Municipality. That results in one of the biggest possibilities for improvement, the development of such a makerspace, being unfeasible at this point in time.

As described in section 5.4.3 there are also still possibilities for improvement regarding the visual side of value proposition development and communication, especially regarding the sustainable impact of a value proposition. Deep-tech is associated with solving grand societal and environmental challenges and impact investments are rapidly increasing. Therefore, a framework targeting the needs regarding sustainable value proposition communication to investors could create significant value for new deep-tech ventures, HighTechXL and investors. Such a framework should include integrating SDG contribution.
into the value proposition and should include the development of venture-specific impact KPIs, based on a theory of change. Additionally, the framework should be easy to use for the venture teams and the HighTechXL employees. Moreover, it should be easy to implement within the current toolset of HighTechXL while adhering to the current venture-building process.
6. Solution design

6.1 Introduction

This chapter describes a solution developed to target the problem described in chapter 1. The framework is developed to help deep-tech ventures develop the sustainability aspect of their value proposition and communicate this to investors. The design solution has been developed through an iterative process, for which an initial design solution was developed. The tool underwent nine alpha tests with different (ex) staff members of HighTechXL, and a managing partner, and the Sustainability Officer of an early-stage deep-tech fund. Afterward, three alpha tests were performed with startups operating in different sectors and of different maturity levels, who received either subsidy, equity funding, or both. During the Beta tests, the tool was filled out with staff members from the C-level performing different roles, and feedback was provided during those meetings.

The solution design consists of four phases. An overview of those four phases is depicted below in figure 15. I developed two of those phases, of which phase two was the main focus throughout this research. The other two are existing frameworks integrated to provide an end-to-end solution covering all aspects regarding a value proposition’s sustainability required for proper investor communication. The first phase is targeted at developing the foundation of the value proposition and is the Value Proposition Canvas developed by Osterwalder & Pigneur (2014). The second phase extends the Value Proposition Canvas to include sustainability by incorporating the other stakeholders, the environment, and society. The framework of SDGs, which is used by HighTechXL, and deep-tech investors serves as the foundation for this. It considers both positive and negative contributions, which are aspects taken from the tool of Bocken et al. (2010). This phase of the solution design is developed by me. The results from Phase 2 will function as a foundation for phase three, which is developing a Theory of Change. There are several methods and guides for developing a Theory of Change, and one publicly available is chosen as the foundation for phase three. The fourth and final phase is the development of impact KPIs. These are based on the Theory of Change developed in phase 3. All four phases will be elaborated upon in this chapter, as well as the alpha and beta tests. Subsequently, the design principles and requirements described in chapter 5 will be reviewed. Then the different iterations the design solution went through will be discussed. Finally, a concluding paragraph will be written and the research question will be answered.
6.2 Phase 1 – The Value Proposition Canvas

The first phase of the Value Proposition Canvas is filling out the Value Proposition Canvas developed by Osterwalder & Pigneur (2014). This phase focuses on developing the value proposition regarding the customer-firm relationship and is based on design principle 2. It is essential a value proposition is of added value to meet customer demands. Without meeting customer demand, the chances of selling products are minimal. This lack of sales makes a business inherently unsustainable, as it cannot sustain itself. Even if a product has a huge potential positive impact on the environment and/or society, none of it is realized if it is not sold. Therefore, it is essential to develop a proper fit between the customer profile and the value map as described below. The first step is to fill out the customer profile. For this, the first step is to fill out the customer jobs. These describe the things customers want to get done. Here it is essential to view this from their perspective and list the things they want to get done in their life or work (Osterwalder et al., 2014). There are three types of jobs, functional, social, and personal/emotional, which are elaborated upon in section 3.3.1. Then the customer pains have to be defined. Customer pains are things customers face before, while, or after performing the respective job that annoys them or is a potential risk (Osterwalder et al., 2014). There are three types of pains, as discussed in section 3.3.1, which are undesired outcomes, problems and characteristics, obstacles, and risks. Finally, the customer gains have to be listed. These are benefits and outcomes the customer tries to achieve by performing their job (Osterwalder et al., 2014). There are four types of gains, also discussed in section 3.3.1: required gains, expected gains, desired gains, and unexpected gains.

The second step is filling out the value map. The first step is listing all the products and services of the venture’s value proposition. These are the things that help the customer
perform their jobs (Osterwalder et al., 2014). There are four types of products and services, as described in section 3.3.1, which are physical/tangible, intangible, digital, and financial. Then there are the pain relievers, which describe how a company aims to decrease the pains experienced by the venture’s customers (Osterwalder et al., 2014). Finally, the gain creators describe how the things listed here help create value for the customer (Osterwalder et al., 2014).

The third and final step after filling out the customer profile and the value map is to see if there is a fit. This is done by comparing the corresponding topics, customer jobs vs. products and services, customer pains vs. pain relievers, and customer gains vs. gain creators. In addition, the importance rankings for these categories in the customer profile and the value map are also compared. This is to determine how well the most important aspects of the customer (segment) are targeted and, thus, the level of fit. If everything is filled out correctly, it should look similar to the example provided below in figure 16.
Figure 16: Filled out Value Proposition Canvas – Tesla example
6.3 Phase 2 – Extension of the Value Proposition Canvas to incorporate the environment and society

Now part 2 of the solution design will be introduced. This part is based on design principles 3 and 4. First, the reason for choosing this solution will be briefly discussed. Afterward, the main building blocks of this solution design phase will be discussed. Finally, a short guide for how to fill in the

The reason for developing Phase 2 of the solution design is that most of the literature regarding value proposition so far, including phase 1 of the solution design, focused solely on the customer-firm relationship (Vladimirova, 2019). As chapters 3 and 4 of this study have shown, there is a demand in practice and literature for integrating other stakeholders, such as society and the environment, into the value proposition. Phase 2 of the design solution aims to do this and make it possible to assess the impact of a value proposition. Some tools aim to include sustainability in developing a value proposition or business model, as described in sections 3.3.2 and 3.3.3. However, these tools mainly apply to the ideation and analysis stages instead of allowing for the development and (effective) communication of sustainable value propositions (Vladimirova, 2019). Therefore, it is rather difficult to implement these tools within the deep-tech industry (cf. Vladimirova, 2019). The tool developed by Vladimirova (2019) is targeted at the later stages of value proposition development and communication. However, it is not linked to integrating the SDGs into the value proposition or forming a foundation for the Theory of Change, which have both shown to be essential for early-stage deep-tech ventures addressing deep-tech investors. Linking the value proposition to the SDGs is also a requirement for all ventures in the HighTechXL building program (Confidential Appendix A, Interviewee 1, 2022). Additionally, the tools described above are very different from the Value Proposition Canvas currently used by HighTechXL, thus requiring a relatively high learning curve while not addressing other important aspects of the venture-building program, the SDGs, and the Theory of Change.

Phase 2 of the solution design can be started after completing phase 1. This phase is an extension of the Value Proposition Canvas. The Value Proposition Canvas is chosen because it is a tool already used by startups and HighTechXL, taught in universities such as Eindhoven University of Technology and Avans, and is already integrated into the Business Model Canvas. The tool requires a smaller learning curve and is easy to integrate into the current venture-building program as the Business Model Canvas is already used. The extension of the value proposition aims to include the impact a certain value proposition has on other stakeholders, such as the environment and society. Including these stakeholders is done by adding two different profiles to the Value Proposition Canvas: the environmental and societal profiles. Both of these profiles have a similar structure as the customer profile and consist of societal/environmental jobs, societal/environmental pains, and societal/environmental gains. These are shown below in figure 17.
Environmental and societal jobs describe things that must be done to make it a better place. As a foundation for these environmental and societal jobs, the framework of the SDGs has been chosen. These SDGs are developed by the United Nations with the objective "to transform our world and to improve people's live and prosperity on a healthy planet" (United Nations, 2019), so they provide a good foundation and a clear overview of things to be done to make the world a better place. In addition, investors often use the SDGs, and certain funds only invest in startups addressing specific SDGs (Confidential Appendix A, Interviewee 1, p. 4; Shift Invest, 2022). Therefore, the SDGs not only provide guidance when developing the impact of a value proposition but, in later stages, also help address investors.

When picking environmental jobs, both positive and negative impacts should be considered. For the positive impact, a venture should pick 1-3 SDGs relevant to their value proposition on which they have the most significant positive contribution. For the negative impact, the venture should pick at least 1 SDG relevant to their value proposition on which they have the most significant negative impact. After choosing the initial SDGs, the venture should try to go deeper within the SDGs and pick a specific target and/or indicator they address. For example, suppose a car manufacturer's autonomous cars would cause fewer traffic accidents and deaths. In that case, they should not only state they target "SDG 3 – Ensure healthy lives and promote well-being for all at all ages" (United Nations, 2022). Instead, they should target SDG 3, Target 6, indicator 1, or for increased simplicity, SDG 3.6.1 – “by 2030, halve the number of global deaths and injuries from road traffic accidents measured by the death rate due to road traffic injuries” (United Nations, 2022). This level of depth is based on feedback from the participant in the second Beta test, who was told it is important by a partner from an early-stage deep-tech fund. These environmental jobs will later serve as input for developing the Theory of Change. Choosing and completing societal jobs is the same process as environmental jobs. If all steps are performed correctly so far, the tool should look similar to the example provided below in figure 18.
Figure 18: Extension of the value proposition where societal and environmental jobs have been completed – Tesla example
After picking 1-3 SDGs to which are positively contributed and at least 1 SDG to which are negatively contributed for the environmental and societal profile, the rest of phase 2 can be completed. The process for filling the environmental profile will be described, and the same process applies to filling the societal profile. The following steps are listing the environmental gains and pains based on the venture’s value map and linked to the environmental jobs. There is no specific order in which they must be filled, and it can also be done simultaneously.

The environmental gains described how a venture wants to contribute to the environmental jobs. There are two types of environmental jobs, required gains and additional gains. This structure is partly based on the types of gains proposed by Osterwalder & Pigneur (2014). Required gains are “gains which are essential for fulfilling your value proposition. If these gains are taken away, the value proposition cannot be delivered”. An example of electric cars would be the increased air quality compared to Internal Combustion Engine (ICE) cars due to the lack of carbon dioxide emissions. If this increase in air quality would not be observed, the value proposition cannot be delivered as it is inherent to electric cars. Additional gains are "gains which are less inherently linked to delivering a value proposition, but where extra environmental/societal value could be created." An example of this in the case of electric cars could be using locally recycled plastics for the interior instead of less environmentally friendly materials sourced from other parts of the world. Electric cars could still be produced, and the value proposition could still be delivered with less environmentally friendly materials, but gains are created for the environment by reducing the carbon footprint of the production and transportation of the chosen material. These environmental gains will later serve as input for developing the venture’s Theory of Change, as described in section 6.4. A startup should aim to list as many relevant environmental gains as possible.

Next to the environmental gains, there are also two types of environmental pains. These are undesired outcomes, problems and side effects, and risks (undesired potential outcomes). These are again partly based on Osterwalder & Pigneur's (2014) work. Undesired outcomes, problems, and side effects are “negative aspects inherently linked to a value proposition. Without these negative aspects, the value proposition could not be delivered.” An example of electric cars would be that until recently, all batteries used in electric cars required cobalt. Mining Cobalt is known to pollute water, air, and soil by the generated waste. This can result in contaminated food and water and reduced crop yields (Bamana et al., 2021). Without cobalt, electric car manufacturers could not deliver on the promised range of their cars, which is essential for delivering their value proposition. By being aware of these negative influences, a company can aim to address these problems. This has already happened in the case of Tesla, an electric car production company, for which over half of newly produced cars do not contain cobalt anymore (Tesla, 2022).

Risks (undesired potential outcomes) are defined as “things that are less inherently linked to, and that do not always happen when delivering the value proposition. They describe what could go wrong and have a significant negative impact on the environment when delivering the value proposition”. For example, in the case of electric cars, it could be an overheating battery causing a chain reaction of all battery cells catching fire and/or exploding. If this happens, high levels of toxic constituents are released into the environment. There is only a small chance of this happening, so it is not inherently linked to the venture’s value proposition. However, when this happens, it does have a significant negative impact on the environment. Awareness of these risks can be addressed by, for example, extra quality checks or changes to the product architecture. These pains can later serve as inspiration for the potential dark side of the venture’s impact KPIs as described in section 6.5. Again, a startup should aim to list as many relevant pains as possible. If all steps described in phases
one and two are performed correctly, the extension of the Value Proposition Canvas is now completed. It should look similar to the example provided below in figure 19.
Figure 19: Completed extension for the Value Proposition Canvas - Tesla example
6.4 Phase 3 – Developing the Theory of Change

The third phase of the solution design is targeted at developing a Theory of Change. It is based on design principle 5 about incorporating impact KPIs related to the Theory of Change when communicating the sustainability aspect of a value proposition to investors to adhere to the investor’s requirements and increase the likelihood of receiving an investment. Oberlack et al. (2019, p. 1) define the Theory of Change ‘as the mental representations and theoretical assumptions that explain how and why activities of an initiative (e.g., projects, programs, organizations) generate particular changes”, which was based on the research of Mason and Barnes (2007). These assumptions will later be reflected upon in combination with the changes made and are, therefore, also a form of knowledge production (Oberlack et al., 2019). There are different methods and guides for developing a Theory of Change. One thing they all have in common is they start with the impact an organization wants to make and, from there, use backward reasoning to gain insights into the required activities and inputs to achieve this impact.

Deep-tech/impact investors require ventures to create value for the environment and/or society. A framework often used by investors for this purpose is the SDGs. Linking the value proposition to the SDGs ensures that the contributions to society and the environment are communicated in a way understandable for investors. However, it remains very abstract how these contributions are achieved by only linking the value proposition to the SDGs. By formulating what intermediate outcomes have to be achieved and what activities have to be performed to achieve those outcomes, it is clearly defined what concrete activities a venture will perform to achieve the promised contributions to society and the environment. This allows the investor to better assess the achievability of the contributions to society and the environment and to evaluate the made assumptions and chosen strategy for achieving this information.

As early-stage deep-tech ventures often do not have a product yet, it is crucial to send other signals, including a proper business plan on how revenue and profit will be generated (Audretsch et al., 2012). For deep-tech/impact investors, it could therefore be reasoned it is important to deliver a proper strategy on how value will be created for society and the environment and how the SDG contributions will be made. This decreases the information asymmetry and could increase trust and the likelihood of receiving investments. A tool applicable to for turning the SDG contributions in a value proposition into concrete actions to be taken is the Theory of Change. It could thus be reasoned that by communicating a well-developed evidence-based Theory of Change describing concrete actions on how SDG contributions will be made decreases information asymmetry, increases trust, and helps early-stage deep-tech ventures better communicate their value proposition to investors.

A very clear and elaborate guide publicly available for developing a Theory of Change is that of Harries, Hodgson, and Noble (2014), employed by NPC, a think tank and consultancy for the charity sector. This guide will thus also be taken as the foundation for this design solution phase and will be briefly summarized. Harries et al. (2014) describe eight main building blocks that all theories of change have in common. The definitions for all of these are provided below in table 13.
Table 13: Main building blocks of the theory of change (Harries et al., 2014)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final goal/impact</td>
<td>The broader social change a project or organisation is trying to achieve.</td>
</tr>
<tr>
<td>Intermediate outcomes</td>
<td>The short-term changes, benefits, learning or other effects that result from what a project or organisation does. These short-term steps will contribute to a final goal and may include changes in users’ knowledge, skills, attitudes, and behaviour. A useful way to think about intermediate outcomes is the outcomes achieved <em>after the project</em>—what service users take away from it.</td>
</tr>
<tr>
<td>Outputs</td>
<td>Products, services or facilities that result from an organisation or project’s activities. These are often expressed quantitatively; for example, number of users, how many sessions they receive and the amount of contact they had with a project.</td>
</tr>
<tr>
<td>Activities</td>
<td>The things that an organisation or project does or the way it chooses to deliver a project day-to-day. Activities are within an organisation or project’s control.</td>
</tr>
<tr>
<td>Inputs</td>
<td>The resources that go into the project that a team or organisation needs to be able to carry out its activities.</td>
</tr>
<tr>
<td>Enablers</td>
<td>Conditions or factors that need to be present or absent to allow an organisation or project’s work to succeed. The presence or absence of enablers can help or hinder a project. There are two kinds of enablers.</td>
</tr>
<tr>
<td>Internal enablers</td>
<td>Internal enablers need to exist inside an organisation for a Theory of Change to work, and are mostly within an organisation or project’s control. Internal enablers describe the mechanisms by which an organisation delivers its work (such as the quality of services, relationships and the values and attitudes of staff).</td>
</tr>
<tr>
<td>External enablers</td>
<td>External enablers need to exist in the external environment for a Theory of Change to work, and are often beyond an organisation or project’s immediate control. External enablers describe the context in which an organisation works (such as social, cultural, economic and political factors, laws, regulations, and working with other organisations).</td>
</tr>
<tr>
<td>Evidence</td>
<td>Information that you already have or plan to collect that is relevant to supporting or testing a Theory of Change.</td>
</tr>
<tr>
<td>Assumptions</td>
<td>The underlying beliefs about how a project will work, the people involved and the context. These are sometimes implicit in a logic model or Theory of Change, but it can be useful to state them explicitly</td>
</tr>
</tbody>
</table>

The first step in developing a Theory of Change is defining the final goal or the impact a venture wants to make. The whole company should support and target these goals and align with its value proposition. The goal should be realistic, and the venture should only define a few final goals. They should be long-term and beneficial, and relevant to the venture’s specific stakeholder, in the case of this solution design, that would be (a part of) the environment or society. The societal and environmental jobs defined in Phase two of the solution design should be used as the final goals or as the foundation for developing the final goals.

The second step is to work backward from the final goal and define the intermediate outcomes necessary for achieving the venture’s final goal. Harries et al. (2014) describe these intermediate outcomes as potentially the most critical step in developing the Theory of Change, as organizations often go directly from their performed activities to the final goal without adequately considering the required intermediate changes to achieve this final goal.
The intermediate changes should be relatively short-term and should be (indirectly) influenceable by the company. In addition, they should be feasible for the venture and preferably be backed by evidence. The guide of Harries et al. (2014) only includes one level of intermediate outcomes. However, there are also guides, including the internal guide of HighTechXL, that implement different levels of intermediate outcomes by defining short-term outcomes contributing to longer-term outcomes. This allows for more depth and could create different levels of accountability between outcomes, which can help define the venture’s impact KPIs in phase 4 of the design solution. The societal and environmental gains defined in phase 2 can serve as a good foundation as they describe intermediate steps a venture takes to contribute to its social and environmental jobs.

After defining the final goals and intermediate outcomes, the third step is to define the activities a venture will perform to achieve the intermediate outcome and accelerate the desired change. For developing the venture’s activities, all individual intermediate outcomes should be considered. A venture is likely already performing activities. It should be reviewed how these activities contribute to a particular intermediate outcome. If, after performing this step, certain intermediate outcomes are still unaddressed, new activities should be defined to ensure all intermediate outcomes are appropriately addressed. When defining these activities, the potential inputs of the venture should already be considered as the venture should, at least in the near future, be capable of performing these activities.

These performed activities all result in a certain output. These outputs are often quantifiable, for example, the number of people saved, metric tons of reduced carbon footprint, or the number of products sold if sales of the venture’s product directly contribute to achieving the intermediate outcomes. The guide of Harries et al. (2014) does not include the outputs in visualizing the Theory of Change. However, some guides, including HighTechXL’s internal guide, implement the outputs into the visualization of the theory change. This could help quantify certain parts of the Theory of Change and provide guidance on what evidence to collect for monitoring the effectiveness of the Theory of Change.

When the activities required for achieving the intermediate outcomes are defined, the required inputs should be defined. As described above, this is already partly done when defining the activities. To achieve the final goal, a venture should be able to perform the defined activities with the inputs it has access to. Examples of inputs could be human resources, knowledge, capital, office space, or a place to give workshops. First, the distribution of the currently available inputs could be determined to try addressing all of the activities. If some activities are still unaddressed, it could be determined what inputs are still required, and the venture could fill up these gaps, for example, by hiring new staff members or office space.

Afterward, the enablers should be defined, which are the things required for the goal to succeed. There are two types of enablers: internal enablers and external enablers. Internal enablers are often directly influenceable by a venture, while external enablers are often not. Internal enablers could, for example, be staff values and attitudes, and external enablers could be laws and regulations.

Finally, throughout the process of developing the Theory of Change, it should constantly be considered what evidence is available to support the venture’s Theory of Change or what evidence has to be collected to provide this support. If a lack of evidence is faced for developing a theory, it is helpful to identify and list the assumptions made throughout the Theory of Change.
There are four different methods described for visualizing a Theory of Change by Harries et al. (2014). They all follow the same principles and use the same building blocks described above. The four methods are of different complexity, and each has its own positive and negative aspects. It would be impossible to pick the best method as this is also highly dependent on the context in which they are used, and due to the lack of an established method, different investors could also require different forms of visualizing the Theory of Change. Therefore, the choice is not to further elaborate on the methods for visualizing the theory change.

6.5 Phase 4 – Developing the impact KPIs

The fourth and final phase of the solution design is targeted at developing the impact KPIs. It is based on design principle 5 about incorporating impact KPIs related to the Theory of Change when communicating the sustainability aspect of a value proposition to investors to adhere to the investor’s requirements and increase the likelihood of receiving an investment.

KPI is short for Key Performance Indicator, defined as: “those indicators that focus on the aspects of organizational performance that are the most critical for the current and future success of the organization” (Parmenter, 2020). KPIs can be company-wide or implemented for a specific product or department and can address a wide range of variables. Impact KPIs, on the other hand, can only address variables related to the impact a company wants to make, as defined in Phase three of the design solution. The reason for adding this fourth phase of the solution design is because the importance of impact KPIs was highlighted in the reviewed FIRs for measuring the impact a venture makes. The CEO of HighTechXL also stated that: “We (HighTechXL) are in the process of introducing new metrics (in the interview previously referred to as KPIs) around sustainability in general, impact. To be quite honest, that is still a struggle to see how companies can measure impact. For a startup, all the more so, of course (Confidential Appendix A, Interviewee 2, p.12)”. This shows that being able to develop proper impact KPIs is also on the agenda for HighTechXL, and there is a need for guidance in this development.

There is little scientific literature available about developing impact KPIs, and there is no established method yet, as confirmed during the interview with the Sustainability Officer (p. 8). Therefore, the methods and requirements below are based on literature about general KPIs and empirical research. There could be different types of impact KPIs, as confirmed by the CEO in interview 2 (p.5) and the Sustainability Officer during alpha test 8. The Sustainability Officer proposes three types of Impact KPIs: venture-specific, venture-general, and investor-general Impact KPIs. Venture-specific impact KPIs should be based on the Theory of Change as proposed by the Sustainability Officer during alpha test five. Because the final goal of the Theory of Change, and thus all the other building blocks as well, differ for each venture, these impact KPIs are also different for each venture. Venture general KPIs are KPIs that are more generalized and could therefore be applied to most ventures. The Sustainable Finance Disclosure Regulation (SFDR) described in section 3.5 includes a list of indicators that could serve as a foundation for developing venture-general impact KPIs. Example categories include Green house gas emissions, biodiversity, and waste. Examples of specific KPIs include Carbon footprint, Share of non-renewable energy consumption and production, and board gender diversity. Investor-general impact KPIs are similar to venture-general impact KPIs in the sense that they could also be derived from the SFDR. The investor-general impact KPIs would represent the combined value for all venture general impact KPIs. This could help in portfolio management to determine what KPIs are still under-addressed and help communicate the impact to external stakeholders.
The choice was made to focus on the venture-specific KPIs for this solution design, as these are the only ones based on the Theory of Change. Therefore, the only KPIs inherently linked to the previous three solution design phases. For the development of the Impact, seven requirements to which they must adhere are proposed. The first two are based on the alpha test performed with the Sustainability Officer and are required for venture-specific impact KPIs only. The last five are based on the book of Parmenter (2020) about developing KPIs and apply to all three categories of impact KPIs. All requirements have been alpha tested, and Beta tested three times. The seven requirements are that the venture-specific impact KPIs must be:

1. Based on the Theory of Change – The venture-specific impact KPIs describe how a venture intends to measure its impact. The Theory of Change is used to correctly deliver this impact and achieve the final goal. By linking the venture-specific impact KPIs to the Theory of Change, it is ensured that the activities they perform contribute to the impact KPIs and the impact KPIs contribute to the final goal.

2. Formulated on the output/outcome level of the Theory of Change – The output/outcome levels are the last levels that the venture can directly influence. Still, they do already directly contribute to the final goal.

3. Non-financial – They should be linked to monetary value and be expressed in euros, dollars, pounds, etc.

4. Simple to understand – All relevant stakeholders should immediately understand what is meant by the KPI.

5. Supported by CEO and upper management and/or relevant stakeholders – Parmenter (2020) stated the KPIs must be supported by the CEO and upper management to ensure the whole company performs activities with the same goal. Based on Beta test two, relevant stakeholders were added. This is because early-stage startups could exist only of a CEO and upper management, and other external stakeholders such as investors could be just as important to receive support from.

6. Have a limited dark side – This targets the potential negative influence measuring one aspect can have on other aspects of the business. The environmental and societal pains formulated in Phase 2 of the design solution can serve as inspiration for the dark side of your impact KPI. Parmenter describes a clear example of a dark side in his book about a city train service. The company introduced the KPI of measuring trains' on-time arrival, and train drivers were severely punished for being late. After the introduction, if train drivers were late, they would not open the doors at a (couple of) station(s) to ensure on-time arrival at the next station. By measuring on-time arrival, many travelers could not get in or out at their destination, which decreased the level of service and customer satisfaction.

7. Measurable – The KPIs should be easy to measure.
6.6 Tests performed

As described in chapter 2, the development of the design solution was an iterative process, starting from an initial design solution and resulting in the final design solution described in sections 6.1 through 6.5. The iterative process included nine Alpha tests and three Beta tests. The alpha tests are summarized in table 14, and the beta tests are summarized in table 15. To reduce bias, the respective persons reviewed the outcomes and decisions from Alpha tests 1, 2, 4, 5, 6, 7, 8, and 9. I was unable to receive a reaction from the person from alpha test three, but all outcomes and decisions derived from this session were implemented into the Beta tests and/or the final design solution. The results and conclusions of the Beta tests were discussed during the Beta test, or a separate feedback session was scheduled. The final solution is based on all of the alpha and Beta tests.

Table 14: Overview of performed alpha tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Version</th>
<th>Date</th>
<th>Goal</th>
<th>Description</th>
<th>Outcome</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>α 1</td>
<td>First draft solution design</td>
<td>19-05</td>
<td>Concept testing with the program manager</td>
<td>Decide whether to extend the VP canvas to incorporate the environment and society to review the impact made by a venture.</td>
<td>The solution design is in the right direction and has potential, but it needs to be further elaborated upon.</td>
<td>The initial idea for the design solution will be further refined in the same direction. SDGs will be included.</td>
</tr>
<tr>
<td>α 2</td>
<td>Initial solution design</td>
<td>10-06</td>
<td>Validate added value of the design solution with the Sustainability Officer</td>
<td>Reviewing the initial design solution.</td>
<td>It could definitely be of added value. Good integration of SDGs. To provide applicability to investors it should be combined with a Theory of Change.</td>
<td>Think about a way to incorporate the Theory of Change</td>
</tr>
<tr>
<td>α 3</td>
<td>Initial solution design</td>
<td>19-07</td>
<td>Get a better perspective on what is important for an investor with a managing partner from a deep-tech fund</td>
<td>Meeting during which the tool was reviewed, and its applicability for investors was discussed</td>
<td>The tool should be able to develop venture specific impact KPIs. For beta testing later-stage startups should also be incorporated as they have more focus on sustainability and it is more tangible already in those companies</td>
<td>Review three FIRs to see to gain insights in sustainability aspect focused on by investors.</td>
</tr>
<tr>
<td>α 4</td>
<td>Improved solution design</td>
<td>21-07</td>
<td>Review the improved extension of the value proposition model and discuss the potential of</td>
<td>Reviewed the improved tool (division of pains, gains and jobs) and the initial idea for</td>
<td>The V-model has potential. The extension of the Value Proposition Canvas is getting shape with the current division of pains, gains, and</td>
<td>Further elaborate upon the V-model. Develop standard profiles for each SDG</td>
</tr>
<tr>
<td></td>
<td>Improved solution design</td>
<td>11-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td>------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gain insights in how impact KPIs are developed with the Sustainability Officer</td>
<td>Meeting about how impact KPIs are developed and how they are linked to ToC</td>
<td>The impact KPIs are based on your ToC and should be developed around the output/outcome level.</td>
<td>Integrate the findings about KPIs into the design solution.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Discuss the new method of integrating the ToC into the design solution, and possible integration of the tool with the BMC with the program manager</td>
<td>The new way of making it more linear where the VP extension forms the foundation for the ToC was discussed</td>
<td>Tool is shaping up really well, curious about what the final result will be.</td>
<td>To finalize the tool and not try to integrate it into the BMC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Decide with the program manager whether the tool is ready to start Beta testing with the ventures</td>
<td>The tool was reviewed to decide whether it was ready to start Beta testing</td>
<td>Tool is ready for Beta testing.</td>
<td>Develop slides that explain all steps to be taken for completing the tool clearly by expanding on the textual instructions and developing accompanying visuals. The results can be seen in Confidential Appendix C and start Beta testing. In addition, a slide was made that showed a completed example of the design solution. This example is shown in section 6.3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**α 8** Improved solution design 18-11
Validate readiness for Beta testing with the Sustainability Officer

The tool was reviewed to see if further improvements should be made.

Good that the tool highlights both the positive and the negative influence on the environment and society. Don’t force positive influence when filling in the tool, could also not have positive influence. The tool could also be used as part of a CRM system. There could be different types of impact KPIs, venture specific, venture general or generic ESG, and investor general.

No further changes have to be made to the tool. Mainly to be critical when filling in the tool.

---

**α 9** Improved solution design 23-11
Validate the improved solution design with a venture support manager

The tool was reviewed a final time to validate readiness for Beta testing.

The foundation of the tool is good. Currently the slides still need a bit of explanation to fill out the tool. The dark side (impact KPIs) could be linked to environmental and societal pains. An idea for future research could be a method to weigh the created gains against the created pains to decide whether a certain value proposition is worth pursuing.

More elaborately explain the tool and its usage in the slides. No further changes needed to the tool.
<table>
<thead>
<tr>
<th>Test</th>
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<th>Description</th>
<th>Outcome</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>β1</td>
<td>Improved solution design</td>
<td>22-11</td>
<td>Validate solution design with end-user</td>
<td>The Tool was explained and filled out with the CEO of an early-stage deep-tech venture</td>
<td>Extension of VP is strong. The framework leads to new insights, especially on the pains side. Requirements for impact KPIs were clear.</td>
<td>No further changes needed based on this test. Additional beta tests will be performed to validate this.</td>
</tr>
<tr>
<td>β2</td>
<td>Improved solution design</td>
<td>22-11</td>
<td>Validate solution design with end-user</td>
<td>The Tool was explained and filled out with the Chief Product Officer (CPO)/Chief Sales Officer (CSO) of an early-stage deep-tech venture</td>
<td>Can be a very useful tool, dependent on the sector in which a venture operates. Better than the normal VP canvas, as there are limited possibilities to look at negative aspects. Risk analysis does exist, but focuses solely on the system itself, this tool includes external stakeholders. Strong linkage with the SDGs. The tool could also be used for a quick analysis of effect of different supply chain choices. Don’t try too hard to link it to the VP canvas, could be used without VP canvas. Can be difficult to make KPIs non-financial. Also when picking SDGs, try to go to the level of targets and/or indicators, as this was told to the participant by a partner of a deep-tech fund.</td>
<td>Change order of the slides to match the template. Consider necessity of making impact KPIs non-financial.</td>
</tr>
<tr>
<td>β3</td>
<td>Improved solution design</td>
<td>18-11</td>
<td>Validate solution design with end-user</td>
<td>The Tool was explained and filled out with the Chief Financial Officer (CFO) and the sustainability focused operations manager of an early-stage deep-tech venture</td>
<td>Tool is very easy to use, proper results can be achieved within an hour. Good that the tool also focuses on the negative impact, a lot of companies do not take that into consideration and only the good parts are highlighted to potential investors. This also provided new insights to this specific startup. Idea for future research</td>
<td>The tool does not need any further changes. A few spelling errors in the slides have to be adjusted. Potentially think about how governance</td>
</tr>
</tbody>
</table>
6.7 Design reflection
In chapter 5, several design principles and design requirements were formulated. These formed the foundation for the developed final design solution described in sections 6.1 through 6.5. This section will describe to what degree they are implemented in the design solution.

6.7.1 Reflection on design principles
This section reflects on the design principles by listing all of them and analyzing how they are implemented in the solution design.

*Design principle 1*  
When developing a startup in the deep-tech industry, sustainability should be considered as a business asset, to meet customer demand and differentiate the startup from competitors, allowing for additional investments/subsidies, and a long-term competitive advantage.

No final conclusion can be drawn regarding the degree to which this design principle, adapted from the thesis of Bunt (2019), has been implemented. It has not been proven directly that the design solution helps meet customer demands, as no tests with final customers have been performed. In addition, so far, no additional investments or subsidies have been obtained by using the design solution. However, SDG reporting is of increasing importance for companies in general. Deep-tech ventures often operate in the business-to-business market, so it can be assumed that sustainability and SDG reporting are also increasingly important to the customers of deep-tech ventures. Additionally, the theoretical and empirical analysis showed the increasing importance of sustainability, both for ventures and investors. By being able to better communicate the sustainable impact made by a deep-tech venture’s product in comparison to competitors, it could be argued that customer demands are met, and competitive advantage is created. The design solution helps map and communicate the sustainable impact, so it would contribute to meeting customer demand. This, in turn, allows for additional investments/subsidies and a long-term competitive advantage. Therefore, it could be assumed that this design principle is at least partly integrated into the design solution.

*Design principle 2*  
When developing a value proposition, the new venture should gain insights into the customers’ pains, gains and jobs, to provide an overall view of a venture’s bundle of products and services that are of value to the customer, to ensure optimal value delivery to the venture’s customers.

Phase one of the solution design was designed by Osterwalder & Pigneur (2014) exactly to perform the task described above. The tool is aimed at developing a value proposition by gaining insights into the customers’ pains, gains, and jobs to provide an overall view of a company’s bundle of products and services that are of value to the customer with the goal of optimal value delivery. This tool is also widely used by startups, ventures, builders, companies, and in education. Therefore, it can be concluded that this design principle is fully implemented into the design solution.

*Design principle 3*  
When developing a value proposition, the new venture should also incorporate other stakeholders such as the environment & society, to
gain insights in the impact the value proposition has on environment & society, to ensure optimal value delivery to other stakeholders such as the environment & society.

Phase two of the solution design is developed to perform the task described in design principle three. This phase includes the two stakeholders, society and the environment, in the development of the value proposition. This is to gain insights into a value proposition's positive and negative contributions to society and the environment to ensure optimal value delivery to these stakeholders. Phase two of the value design solution also went through several beta tests. The participants also stated the tool resulted in new insights into the environmental and/or societal impact. Therefore, it can be concluded design principle 3 is fully integrated into the final design solution.

**Design principle 4** When developing the sustainability aspect of the value proposition, it should be linked to the SDGs, to use frameworks generally understood by customers and investors, allowing for proper communication of the value proposition’s impact.

Phase two targets the integration of the SDGs in the development of a value proposition. It does so in a simple visual to try to increase ease of development and communication. This ease of use was confirmed during the feedback session Beta test three, which stated that the tool was easy to use and relevant results could be achieved within an hour. Because phase two of the tool links the value proposition to the SDGs, it can be concluded design principle 4 is also integrated into the solution design.

**Design principle 5** When communicating the sustainability aspect of the value proposition to investors, the venture should incorporate impact KPIs related to its Theory of Change, to adhere to the investor’s requirements, increasing the likelihood of receiving an investment.

Phases three and four of the solution design target this design principle. Phase three addresses the development of a theory change by taking the guide developed by Harries et al. (2014) as a foundation. The development of the Theory of Change is necessary for developing the impact KPIs. These impact KPIs are required for certain investors, including investors with which HighTechXL and its ventures have a close relationship. Phase four of the tool provides guidance in developing and formulating the three types of impact KPIs but focuses on the venture specific impact KPIs. Phase four describes seven requirements to which these impact KPIs have to adhere. Overall to design solution incorporates the development of impact KPIs related to a Theory of Change. Therefore the conclusion can be drawn that this design principle is integrated into the solution design.

**Design principle 6** When communicating a value proposition to investors, as many relevant signals as possible should be sent, to decrease the information asymmetry, increasing the likelihood of receiving an investment.

This design principle is not entirely integrated into the design solution. An overview of relevant signals is provided in section 3.5. While some of these signals might be implicitly integrated into (extension of) the value proposition or in the Theory of Change, they are not explicitly mentioned and sent to investors by completing the design solution. However, the design solution sends the signal of the desired impact a startup has, which is of increasing importance, as can be denoted by the increase in impact investment and the introduction of the SFDR described in section 3.5. The conclusion can therefore be drawn that the tool does increase the ease of development and communication of sustainability, which is of
increasing importance. However, many relevant signals are not sent by performing the solution design. Therefore, design principle 6 is not fully integrated into the design solution, and ventures should still ensure to send other relevant signals to investors.

6.7.2 Reflection on the design requirements

This section will describe how the design requirements described in section 5.3 have contributed to the final solution design. The developed evidence-based framework aims to improve the communication of HighTechXL’s ventures to investors structurally. Within the communication of the value proposition, the focus is on communicating the impact on external stakeholders, such as the environment and society. The value proposition's impact on the environment and society is linked to the SDGs. Therefore, the first functional design requirement, “The design solution should link the value proposition of a venture to the SDGs.” is integrated into the solution design.

The developed design solution is based on an extensive theoretical and empirical analysis. It is based on theoretical constructs such as signaling theory, Theory of Change, Value Proposition Canvas, and sustainable business model innovation. In addition, it aligns with recent changes in the market and regulations, such as the significant increase in impact investing, the rise of impact funds, and the SFDR introduction. Finally, the results from the FIRs, participant observations, available documents, informal discussions, interviews, and the alpha and Beta tests all contributed to the final solution design. Accordingly, it can be concluded that the solution design is evidence-based. The reviewed FIRs all showed that the deep-tech investment fund required linking the value proposition to the SDGs and developing impact KPIs based on the Theory of Change. The developed design solution targets both of these requirements in phases two through four. Thus, it can be concluded that the solution design helps better communicate (part of) the value proposition to investors. Therefore, the third functional design requirement, “The design solution should be evidence-based and better help communicate (part of) the value proposition to investors” is integrated into the design solution.

As described in the previous paragraph, the solution design helps in linking the value proposition to the SDGs. By adding positive and negative contributions to the respective SDGs, the SDG impact is easily visualized and linked to activities performed within the company. Subsequently, these contributions to the SDGs are integrated into the Theory of Change in phase three, from which impact KPIs are derived in phase three. However, this impact is not yet quantified, and no method was developed to weigh the gains created on one SDG against the pain created on another SDG. This shows there is still a possibility for improvement in quantifying the SDG impact. Despite this possibility for improvement, it can be concluded that the tool does aid in communicating the SDG impact of a venture to investors. Therefore, the second design requirement, “The design solution should aid in communicating the SDG impact of a venture to investors” is integrated into the design solution.

The design solution has been reviewed through a Beta test with three different ventures. All three confirmed that the tool is easy to use and can quickly generate new insights. One of the participants for the Beta tests is also employed by HighTechXL. Accordingly, the tool is also easy to use for HighTechXL employees. Therefore, the first user requirement, “The design solution should be easy to use for venture teams and HighTechXL employees” is also integrated into the design solution.

The design solution consists of four phases. The first and the fourth phase are tools that are already integrated into the venture-building program of HighTechXL. There are also workshops integrated into the venture-building program for both phases. The second phase
extends the first phase and follows a similar approach. The output of this phase also serves as the foundation for the Theory of Change developed in phase three. The results from phase three and the environmental/societal pains developed in phase three guide in developing the impact KPIs for phase four of the design solution. The design solution has integrated two tools already used in the venture-building program. The other phases, two and four, either elaborate on, or serve as the foundation for phases one and three. Additionally, the design solution is currently implemented within HighTechXL. Therefore, it can be said that the second user requirement, “The design solution should be easy to implement within the existing set of tools, templates, and workshops by HighTechXL” is integrated with the design solution.

To provide an answer to the first boundary requirement, the program director was contacted as he is best able to determine whether the framework adheres to the current venture-building process. The reasons provided to the program director are that it adheres to the current venture-building program of HighTechXL, include that the final solution design is a visual tool that is regularly used within the current venture-building program. Also, the tool can be explained using the same structure for a workshop as used with other workshops. Finally, the tool integrates the Value Proposition Canvas and the Theory of Change, two tools already integrated into the venture-building program. The tool logically extends on these tools. The program manager agreed with these points and that the framework adheres to the current venture-building process of HighTechXL. Additionally, the framework is currently implemented in the venture building program of HighTechXL. The first boundary condition, “The framework must adhere to the current venture-building process of HighTechXL,” is thus integrated into the final solution design.

Finally, the design solution focuses on developing the value proposition and its impact in phases one and two. In phase two, the value proposition is linked to the SDGs, a framework often used by investors. Phase three focuses on integrating these SDG contributions into the Theory of Change, another framework often used by deep-tech investors. A value proposition's positive and negative contributions to the SDGs, combined with the developed Theory of Change, help communicate the value proposition to deep-tech investors, as both are required. The tool has been Beta tested with new deep-tech ventures. Therefore, it can be concluded that the second boundary condition, “The framework must focus on developing and communicating the value proposition of new deep-tech ventures to investors,” is integrated into the design solution.

6.9 Conclusion regarding solution design

The proposed evidence-based framework aims to structurally improve the value proposition communication to investors. The design solution is partly based on tools and workshops already implemented within HighTechXL. The design solution consists of four phases, each having a different function, and each phase serves as input for the next phase. In phase one, the ventures must develop their value proposition regarding the customer-firm relationship to ensure a proper fit by using the Value Proposition Canvas (Osterwalder & Pigneur, 2014). Phase two extends on this Value Proposition Canvas to link the value proposition to the SDGs and integrate the impact a value proposition has on society and the environment. During phase three, a Theory of Change is developed to ensure all activities performed within a company contribute to its final goal. In phase four, an overview of different types of impact KPIs is provided, and seven requirements are proposed for developing venture-specific impact KPIs. Five of these requirements apply to all impact KPIs. These four phases integrate several frameworks and requirements often used by deep-tech investors, such as SDGs, Theory of Change, and venture-specific impact KPIs.
This allows HighTechXL’s ventures to better develop and communicate the sustainability aspect of their value proposition to investors.

The development of the final solution design was an iterative process. Alpha and beta tests were performed to develop these iterations. In total, nine alpha tests were performed with the goals of concept testing, refinement, and validating readiness for beta testing. The three performed Beta tests focused on ease of use, added value, applicability, and validating the final solution design with the end-user. The design principles and requirements formed conditions to which the final solution design had to adhere. For design principle 1, no definitive proof has been provided. Design principles 2, 3, 4, 5, and 6 were all proven and integrated into the final design solution.

To conclude, the framework provides a working end-to-end solution for developing the sustainability aspect of a deep-tech venture’s value proposition and better communicating it to investors. Therefore, it provides an answer to the research question about what methods deep-tech venture builders can use to better develop and communicate its deep-tech venture’s value proposition to investors. The framework is based on evidence collected from a thorough theoretical and empirical analysis. The final solution design is developed through an iterative process and underwent nine alpha tests with four different (ex) employees of HighTechXL, two of which have fulfilled prominent roles at an early-stage deep-tech fund. Additionally, three beta tests were performed with C-level staff members of different deep-tech ventures of various maturity levels to ensure applicability in practice. It links the SDGs to the value proposition and aids in communicating this impact to investors. Additionally, it shows how the societal and environmental jobs, pains, and gains can serve as the foundation for developing a Theory of Change. Moreover, it proposes requirements to which venture specific impact KPIs, based on a Theory of Change, have to adhere. The tool is evidence-based and easy to use for venture teams and HighTechXL staff members. It is easy to implement in the existing set of tools, templates, and workshops of HighTechXL and focuses on developing and communicating the value proposition of new deep-tech ventures to investors. Finally, the framework is currently implemented in the venture-building program of HighTechXL indicating that it creates significant value for HighTechXL and its ventures the development of sustainable value propositions and effective communication to investors.
7. Conclusion and discussion

This thesis aimed to develop an evidence-based framework to be used by deep-tech ventures to better communicate their value proposition to investors. This framework resulted in the final solution design described in chapter 6. This chapter will provide an answer to the research question and discuss the contributions made to theory, limitations of this study, implications for future research, and practical implications and recommendations.

7.1 Answer to research question

This thesis resulted in a framework aimed at better developing and communicating the value proposition of deep-tech ventures to investors, and a final solution design has been developed. There was one main research question formulated and three sub-questions. This chapter aims to answer the main research question, while sub-question 1, 2, and 3 were answered in chapters 3, 4, and 5, respectively. Chapter 6 describes the developed solution design.

In the theoretical analysis, the findings regarding the methods for developing a value proposition were divided into three categories: semantics, visuals, and tangibles, after which the findings for investor communications were discussed. The findings will be discussed in this same order.

The research conducted throughout this thesis has led to the development of an evidence-based framework for better developing and communicating the value proposition of deep-tech ventures to investors. First, the findings regarding semantics were discussed. Here an overview of different definitions of value proposition was provided. After this, the evolution of what a value proposition embodies was discussed. The main development was that initially, a value proposition only focused on the customer-firm relationship. Later other stakeholders, such as the environment, society, and network actors, were proposed to be included. These are relevant for deep-tech as it is associated with solving grand societal and environmental challenges. Finally, Straker and Nusem’s (2019) model was introduced, which helps in developing the ‘why’ for delivering a value proposition and developing an articulated narrative, which deep-tech ventures often lack.

In the theoretical analysis regarding visuals for developing value propositions, three tools serving this goal were described. In addition, the potential of using simulations within deep-tech was described. The tool described in section 3.3.1 served as the foundation for phases 1 and 2 of the final solution design. From the tools described in sections 3.3.2 and 3.3.3, several aspects were integrated into the final solution design, such as the including of additional stakeholders and considering both positive and negative contributions for these stakeholders derived from a value proposition. Some of the tools described in this paragraph only apply to the ideation and analysis phases. The final solution design was made to be an end-to-end solution for developing and communicating the sustainability aspect of the value proposition to investors. Simulations were shown to be applicable to deep-tech due to the high costs and long development times associated with deep-tech combined with the increased access to and falling costs of the computation power required for simulations. An overview of several analysis methods suitable for deep-tech was provided.

The theoretical analysis regarding tangibles provided valuable insights. Having developed a prototype is a valuable method for communicating the value proposition, as it is one of the signals described in section 3.5. However, deep-tech is associated with high development costs and long development times, making it challenging to quickly and cheaply iterate on
several prototypes. To accelerate the development of products within deep-tech, partners should be included (Portincaso et al., 2019), and DBTL cycles should be implemented (Portincaso et al., 2021). The description for each of these phases is provided in section 3.4, but they help accelerate breakthrough solutions for big societal and environmental problems. Finally, ecosystems are essential for deep-tech product development. Section 3.4 describes four traits of a well-functioning deep-tech ecosystem. In addition, the required actors and the interactions among them were described in section 3.4.

Financial resources are essential for a company’s survival, growth, and development and are often external investments. Deep-tech ventures have a long and expensive valley of death due to a product's long development times and high development costs. This can make attracting funding challenging. A literature stream relevant to (early-stage) ventures is signaling theory. Here the goal is to decrease the information asymmetry between a venture and an investor by sending as many relevant signals as possible. An overview of relevant signals is provided in section 3.5. One workshop worth mentioning is the workshop on mission and vision, which requires venture to link those to the SDGs, a framework implemented in the final design solution. An additional signal relevant for deep-tech/impact investors is the impact they intend to make. Due to the SFDR introduction, ventures operating within the EU are obliged to report on this when reaching a certain scale. Frameworks often used by investors to report sustainability are the SDGs and the Theory of Change.

The empirical analysis describes how HighTechXL currently deals with the four topics described in the theoretical analysis. HighTechXL has various templates, workshops, and (external) employees for developing and communicating the semantic side of a value proposition. An overview of these is provided in section 4.3. HighTechXL has already implemented the broader definition of what a value proposition embodies, including the team and sustainability.

Regarding the visual side of the value proposition, HighTechXL has implemented a diverse set of tools, templates, and workshops for developing and/or communicating the value proposition. An overview of these is provided in section 4.4. Two templates and workshops worth mentioning here are the Value Proposition Canvas and the Theory of Change, as these are both implemented in the final solution design. HighTechXL has also already implemented the use of simulations when necessary. The use of simulations allows HighTechXL to, amongst others, perform rapid feasibility studies. For this, the services of partners within the deep-tech ecosystem are used.

For developing the tangible side of the value proposition, there are also different workshops, templates, and partners, which all help in building a first demonstrator, prototype, MVP, or product. Again, an overview of these is provided in section 4.5. HighTechXL has developed a network of partners that fulfill the roles of the seven actors described by Portincaso et al. (2019). An overview of examples for all actors in the Brainport region is provided in section 4.5. HighTechXL has partners or external experts for all KPIs in the venture-building program and is constantly optimizing how to utilize the knowledge and services of these partners optimally and how HighTechXL can be of added value to those partners. The ecosystem also demonstrates the four traits linked to a deep-tech ecosystem.

For optimizing investor communication, HighTechXL has implemented a set of templates, workshops, and informal meetings with investors. An overview of these is provided in section 4.6. The signals described in section 3.5 are discussed and it is reviewed, which apply to HighTechXL. The shift to investors wanting to make an impact is also noticed and targeted within HighTechXL. They do this, among others, through workshops, requiring the value
proposition to be linked to the SDGs, and one of the 8 KPIs in the program being sustainability. However, no framework is implemented for linking the value proposition to the SDGs. The empirical analysis also showed that deep-tech investors require impact KPIs linked to the Theory of Change and SDG reporting.

The theoretical and empirical analysis provided an overview of the methods HighTechXL and its ventures can use for better development and communication of the value proposition to investors. The most relevant possibilities for better communicating the value proposition of new deep-tech ventures to investors were within the tangible and visual forms of communication. For tangibles, a promising method that would aid the development of products and prototypes which could help in communicating the value proposition to investors. This method was proposed in the literature and the empirical analysis showed it to be one of the biggest possibilities for improvement within HighTechXL. However, this research direction could not be pursued as the significant capital required for such a makerspace is unavailable. A second method where significant value could be created was a visual tool focused on the sustainable impact of value proposition. Both the empirical and theoretical analysis showed a need for integrating the effect a value proposition has on environment and society and that SDGs are a suitable framework for this. SDGs are also an important framework used by investors. Both analyses also showed that there currently are no tools available that integrate the SDGs in the value proposition. Therefore, the choice was made to develop a visual tool targeting the sustainability aspect of developing and communicating the value proposition to investors. The reasons for this choice are further elaborated upon in section 5.4. An evidence-based solution design was developed, which is explained and reviewed in chapter six. It is a four-phased solution design that integrates tools already used in the venture-building program with findings from the theoretical and empirical analysis. Examples are the Value Proposition Canvas, integration of the stakeholders society and environment, SDGs, Theory of Change, and impact KPIs. The result is an end-to-end evidence-based solution for helping deep-tech ventures develop and communicate the sustainability aspect of their value proposition to investors that is currently implemented within HighTechXL. To conclude, one of the methods deep-tech venture builders can use to better communicate its deep-tech venture’s value proposition to investors includes an evidence-based framework targeted at integrating the SDG impact into the value proposition; Developing a theory of change based on the SDG impact; and requirements for formulating impact KPIs that allow monitoring the progress toward the SDGs.

7.2 Contributions to theory

This study aimed to develop an evidence-based framework that deep-tech ventures and deep-tech venture builders can use for better developing and communicating the value proposition of new deep-tech ventures to investors. Firstly, this study highlighted and summarized the methods available for deep-tech ventures to develop and communicate their value proposition to investors within the categories of semantics, visuals, tangibles, and investor communication. Secondly, it highlighted and summarized the methods, tools, and templates currently used by a venture builder in practice to develop and communicate the value proposition to investors. Finally, the theoretical and empirical analysis findings were combined to form design principles and requirements that formed the foundation for the design solution.

This thesis extends the literature on value proposition design (Osterwalder & Pigneur, 2014; Chesbrough and Rosenbloom, 2002; Barnes et al., 2009; Rantimäki et al., 2007) and sustainable value (Bocken et al., 2013; Yang et al., 2017), as the former only focuses on the customer-firm relationship and the latter proposes tools mainly applicable to ideation and analysis stages without the ability to develop and (effectively) communicate sustainable
value propositions (Vladimirova, 2019). In this thesis, I integrated this literature by linking the value proposition to the SDGs and developing a four-phase solution design allowing for effective development and communication of the sustainable value proposition to investors. Also, most literature regarding value proposition design is about business-to-consumer markets or non-deep-tech business-to-business markets. This thesis highlighted the aspects of value proposition design applicable to the deep-tech industry.

In addition, this thesis extends the limited literature available about developing impact KPIs, first by highlighting the importance of impact KPIs to deep-tech investors. Highlighting the importance of these impact KPIs could also be considered a contribution to signaling theory (Huang and knight, 2017; Audretsch et al., 2012), as this signal was not discovered during the theoretical analysis. Secondly, I combined findings from the empirical analysis with literature about developing regular KPIs to formulate seven requirements to which venture-specific impact KPIs must adhere. Such requirements for venture-specific impact KPIs have not been formulated before and could thus be considered a theoretical contribution.

Additionally, this research has shown that when communicating the impact of your value proposition to investors a Theory of Change should be included. This theory of change turns the desired impact into concrete actions and would allow the investor to not only assess the desired impact, but also the strategy through which this impact will be achieved. This decreases the information asymmetry, which could increase trust and therefore increase the likelihood of receiving an investment. Therefore, a theoretical contribution is that the Theory of Change can be used by new deep-tech ventures to better communicate their value proposition to investors.

Finally, the thesis mapped part of the Brainport deep-tech ecosystem using the structure proposed by Portincaso et al. (2019) by providing examples for all seven actors. The example of the Brainport region could be of added value to other regions because it has emerged as a leading ecosystem for deep-tech entrepreneurship in Europe (Romme, 2022).

7.3 Limitations
While this study contributes to the extending literature and alpha and beta tests were performed to show validity, it also has its limitations. The first being that the study is performed for one company operating only in the deep-tech industry. Therefore, no predictions can be made about the generalizability to other settings (Chatterjee, 2017). The tool was beta tested with positive results with three ventures operating in different sectors to test the generalizability of the solution design. However, all of these ventures were developed through HighTechXL’s venture-building approach, for which the solution design was specifically designed. Therefore generalizability to other deep-tech venture builders cannot be guaranteed. Also, the available research period was only six months, and all of the data sources for the empirical research were based in the Brainport region. Entrepreneurial and investor landscapes can differ immensely per region. Thus, generalizability to other regions cannot be ensured.

In addition, the design solution solely focuses on developing and communicating the sustainability aspect of a deep-tech venture’s value proposition to investors. While this is important within the deep-tech industry, the solution design does not include other factors proven to be important for investors. However, these factors have been described in sections 3.5 and 4.6. Also, deep-tech ventures often communicate with deep-tech or impact investors, for which it is shown they value sustainability. This cannot be ensured for investors operating in different industries or with a different focus.
Additionally, design principle six is not fully integrated into the final design solution. While the solution design helps in better communicating the sustainability aspect of a deep-tech venture’s value proposition to investors, many other relevant signals for investor communication are not sent. This results in ventures using this tool, to additionally send as many relevant signals as possible when communicating with investors.

Moreover, one of the biggest pain points currently experienced within HighTechXL is the lack of facility with shared equipment where deep-tech ventures could test and develop their prototypes and products. Due the significant capital required for developing such a makerspace, which is currently unavailable within HighTechXL or the Eindhoven Municipality, such a makerspace could not be developed. As the makerspace could not be developed, a final solution design in this direction could not be researched, as its effectiveness could not be tested in practice.

In addition, the design solution itself has some limitations. The first limitation arises from alpha test 9. That is, the design solution does not incorporate a method for precisely measuring and quantifying the impact on the environment and society. Consequently, it does not incorporate a method for weighing the positive and negative contributions within or among different SDGs. The choice was made not to integrate this into the developed solution design as it would not be feasible to do it adequately within the limited time period available for this thesis in addition to the already conducted research and developed solution design. With a topic so important and susceptible to being used for greenwashing, it should be ensured that all efforts to address this topic should be made with adequate time and resources. The decision not to incorporate this was made in agreement with the participant in alpha test 9.

In addition, the research method itself has limitations. It relies partly on participant observations, which could introduce bias as the research takes on the role of both practitioner and researcher (Schwartz & Schwartz, 1955). This causes a subjective interpretation of situations, which a second researcher cannot correct. To counter this, interviews were recorded, transcribed, and coded to validate and formalize findings to minimize bias. An extra measure for minimizing bias was the usage of different data sources, including but not limited to observations, HighTechXL employees, venture teams, investors, internal documents, scientific literature, and reports.

Finally, different research methods or settings could have resulted in another solution design. To minimize this, design principles and design requirements were formulated and reviewed, forming the foundation for the research design. For developing the different iterations of the design solution, it went through 9 alpha tests with four different (ex) employees of HighTechXL and the managing partner of an early-stage deep-tech fund. The outcomes and decisions were reviewed where possible to reduce bias.

7.4 Future research
Based on the limitations discussed in section 7.3, several options for future research are provided in this section. First, the same research could be done using a different method to check if it would result in a similar design solution. Secondly, the same topic could be researched in a different industry or location to see if it would result in a similar design solution. Moreover, the generalizability of the solution design could be researched for deep-tech venture builders in a different location, other types of venture builders, or a totally different industry by conducting additional Beta tests using the developed design solution. Due to the limited time period available for this study, a longitudinal study could create additional or different insights. Additionally, the added value of the tool could be verified by
using it when a deep-tech venture is actively trying to attract external investments to validate the increased likeliness of obtaining subsidies or other external investments.

This thesis has provided a clear overview of findings and methods applicable for developing and communicating a deep-tech venture’s value proposition to investors. The choice was to focus on creating a tool to develop and communicate the sustainability aspect of a deep-tech venture’s value proposition. Additional research could be conducted to create a visual tool geared towards other aspects of the value proposition, or a solution design could be created targeting the semantic or tangible side of value proposition development and communication. This could provide additional methods that allow new-deep tech ventures to more effectively communicate their value proposition to investors. An example of such a method provided in this thesis is the development of a makerspace, if the required capital would become available.

To add an extra level of depth to the developed design solution, research could be conducted about how to adequately measure the impact made on the environment and society and link this to the SDGs. Additionally, research could be conducted about how to weigh the positive and negative contributions within or among different SDGs, for example, by comparing the increased air quality caused by electric cars due to the lack of carbon dioxide emissions versus the soil contamination or harmful working environments caused by mining cobalt and nickel. This could help determine whether it is worth pursuing a certain value proposition from a sustainability perspective.

Moreover, if in the future the capital required for developing a deep-tech focused makerspace would become available within HighTechXL or other actors in the ecosystem, a framework could be developed about this topic. The framework could then also be implemented and its effectiveness could be tested in practice.

Finally, the participant from alpha test 9 suggested the tool could also be used as part of a Customer Relationship Management (CRM) tool for analyzing the impact on the environment and society of serving different customers. This could help in determining whether serving a particular customer would comply with the developed Theory of Change or code of conduct of a venture. For example, a steel producer would have a very different impact on society when serving a MedTech company building medical equipment vs. serving a weapons manufacturer. Additional research could be conducted on the applicability of the final solution design as part of a CRM system.

7.5 Practical implications and recommendations

The framework developed in this thesis allows deep-tech venture builders and deep-tech ventures to better develop and communicate the sustainability aspect of the value proposition to investors. This section will highlight the implementation of the design solution for HighTechXL and the ventures. When HighTechXL uses the tool, it is recommended to explain the tool to its ventures through a workshop. The second recommendation is to record this workshop so the venture teams can review it later. The workshop will most likely start with an explanation of the design solution and the possibility for the participating ventures to ask questions. Afterward, the venture teams will be asked to complete several or all phases of the design solution, depending on the venture’s needs. Later a feedback moment will be planned for reviewing the results. This structure for a workshop is similar to other workshops provided by HighTechXL. The suggested slides for the workshop are included in Confidential Appendix C. Providing workshops with a similar structure have shown to be effective in the venture-building program of HighTechXL. Therefore, using a similar structure for this design solution would ensure effective use of the design solution resulting in a value proposition that creates value for society and the environment.
It could differ per investor how they want the main building blocks described in 6.4 to be developed. In addition, different investors could require different ways of visualizing the Theory of Change as no established method has been developed yet. The recommendation would be to align with often contacted investors about how they want a Theory of Change to be visualized. The four methods described in the guide developed by Harries et al. (2014) could serve as a foundation. The method for visualizing the Theory of Change could also be aligned with other venture builders, accelerators, and/or the network of investors operating in the Brainport region to set a ‘brain-port standard’. Such a standard would allow for more effective communication and interpretation of a Theory of Change among different actors of the Brainport deep-tech ecosystem.

For people inexperienced with Theory of Change, the recommendation would be to read the guide developed by Harries et al. (2014) to get a deeper understanding and a more detailed guide than provided in this thesis. This allows for the creation of a solid Theory of Change and increases the likelihood of achieving the desired impact.

If HighTechXL or other parties want to develop the design solution further to integrate measuring and quantifying the impact on the environment and society, the recommendation would be to perform another research thesis following the design science approach to extend the final solution design further. This would allow for weighing positive contributions one SDG against negative contributions on another SDG and would allow for maximal value creation for society and the environment.

Finally, if HighTechXL decides to implement this tool in the venture-building program, it is recommended to give one employee the final responsibility for improving and giving the workshop. This same person should also review the deliverables and provide feedback to ensure consistency and allow for proper development and communication of the sustainability aspect of a venture’s value proposition to investors.
References


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## Appendix

### Appendix A - Overview of definitions for key terms Value Proposition Canvas from Osterwalder et al. (2014)

*Table 16: Overview of definitions for key terms Value Proposition Canvas from Osterwalder et al. (2014)*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional job</td>
<td>When your customers try to perform or complete a specific task or solve a specific problem.</td>
</tr>
<tr>
<td>Social job</td>
<td>When your customers want to look good or gain power or status. These jobs describe how customers want to be perceived by others.</td>
</tr>
<tr>
<td>Personal/emotional job</td>
<td>When your customers seek a specific emotional state, such as feeling good or secure.</td>
</tr>
<tr>
<td>Undesired outcomes, problems and</td>
<td>Pains are functional, social, emotional or ancillary. This may also involve undesired characteristics customers don’t like.</td>
</tr>
<tr>
<td>characteristics</td>
<td></td>
</tr>
<tr>
<td>Obstacles</td>
<td>These are things that prevent customers from even getting started with a job or that slow them down.</td>
</tr>
<tr>
<td>Risks</td>
<td>What could go wrong and have important negative consequences</td>
</tr>
<tr>
<td>Required gains</td>
<td>These are gains without which a solution wouldn’t work.</td>
</tr>
<tr>
<td>Expected gains</td>
<td>These are relatively basic gains that we expect from a solution, even if it could work without them.</td>
</tr>
<tr>
<td>Desired gains</td>
<td>These are gains that go beyond what we expect from a solution but would love to have if we could. These are usually gains that customers would come up with if you asked them.</td>
</tr>
<tr>
<td>Unexpected gains</td>
<td>These are gains that go beyond customer expectations and desires. They wouldn’t even come up with them if you asked them.</td>
</tr>
<tr>
<td>Physical/tangible products and services</td>
<td>Goods, such as manufactured products.</td>
</tr>
<tr>
<td>Intangible products and services</td>
<td>Products such as copyrights or services such as after-sales assistance.</td>
</tr>
<tr>
<td>Digital products and services</td>
<td>Products such as music downloads or services such as online recommendations.</td>
</tr>
<tr>
<td>Financial products and services</td>
<td>Products such as investment funds and insurances or services such as the financing of a purchase.</td>
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</table>