SUSTAINABLE INNOVATION IMPLEMENTATION IN DUTCH HORTICULTURE

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EXECUTIVE SUMMARY

The Dutch horticulture sector (Dhc sector), with its century-long history, is responsible for 1% of the country's GDP and is one of the nine Topsectors in the Netherlands. The sector is world leader in horticultural production and trade due to its high specialization and production efficiency. However, despite government intervention, the sector has been unable get closer to reaching sustainable targets. At the same time, sustainable startups the suppliers of sustainable innovations, are faced with innovation barriers and challenges.

Sustainable startups play a significant role in creating new sustainable business models that can help achieve this transition towards sustainable economies. However, startups often face barriers in bringing their business models to the market. These challenges include the famous Valley of Death, but also other factors such as financial, sectoral and political, which hamper the implementation of their sustainable innovations.

This study aims to identify the innovation barriers that sustainable startups face in the Dhc sector and find ways to overcome them to implement their sustainable business models effectively. As such, the following main research question was proposed:

"How can startups with sustainable innovations overcome barriers by means of niche strategies to implement their sustainable business model in the Dutch horticultural sector?"

This study aimed to address the research question by developing the STN model, which assists sustainable startups in formulating and implementing niche strategies to facilitate sustainable transitions. The model integrates the Sustainable Business Model Canvas (SBMC), Technological Innovation Systems (TIS) framework, and Niche strategies to help startups visualize and optimize the impact of their niche strategies on their sustainable business models.

To validate the STN model and assess its practical utility, it was applied to two sustainable startups in the Dhc sector. This required acquiring in-depth knowledge of the innovation system of the sector. Stakeholder analysis and qualitative interviews were conducted to gain insights into the sector-specific aspects and barriers to sustainable innovation. The study identified six barrier clusters with specific innovation barriers in the Dhc sector. These findings were incorporated into the STN model to highlight the innovation barriers that sustainable startups in the sector must overcome.

The practical implementation of the STN model, combined with sector knowledge, led to notable observations. One startup found the model highly beneficial for assessing the technological viability of the innovation and selecting appropriate niche strategies. Furthermore, the visual expression of the model was found to be effective in facilitating communication among the startup team regarding their niche strategies. Feedback emphasized the importance of regularly revisiting of the assumptions made during the

niche strategy formulation process. Continuous evaluation and adjustment of strategies were recognized as critical for maintaining relevance and effectiveness. The STN model proved valuable as an online tool for iterative evaluation and adjustment.

The flexibility of the assessment criteria within the STN model allows startups to adapt and utilize it at various stages of their journey, enhancing its practicality. Accurate assessment of hindering building blocks and influential factors within the TIS framework enables startups to identify areas requiring improvement and formulate relevant niche strategies. By selecting multiple niche strategies for specific situations, startups can efficiently enhance their business development. These strategies can be organized into a timeline, creating an implementation plan that can be continually revisited and re-evaluated.

This study contributes to both scientific and managerial fields. It provides a comprehensive understanding of innovation barriers in the Dhc sector, expanding the applicability of the TIS framework and introducing the STN model. The insights gained are valuable for entrepreneurs, business leaders, and other managerial roles, as they identify the specific knowledge requirements for applying the model in other innovation systems and sectors. The findings offer practical guidance for startups seeking to navigate barriers and drive sustainable transitions in their respective industries.

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LIST OF ABBREVIATIONS

Abbreviation	Definition	Description
BMC	Business model canvas	A visual tool that helps entrepreneurs and businesses to develop and communicate their business model in a concise and structured way.
BMI(s)	Business Model Innovation(s)	The process of creating or changing a company's business model to better meet the needs of customers or respond to market opportunities or disruptions, and to achieve sustainable competitive advantage.
CHP	Combined Heat and Power (see also WKK).	A technology that generates electricity, heat and carbon dioxide simultaneously from fossil fuels.
Dhc sector	Dutch horticulture	A sector of the Dutch economy that cultivated biological material (e.g. flowers, plants, fruits and vegetables) in greenhouses.
EU	European Union	A political and economic union of 27 member states established with the aim of promoting peace, stability, and prosperity in Europe.
GDP	Gross Domestic Product	A measure of the economic output of a country, which represents the total value of all goods and services produced within its borders in a given period.
Ha	Hectar	A unit of area measurement commonly used in agriculture, equal to 10,000 square meters (m^2).
KIJK	Kennis in je Kas	A Dutch program that promotes innovation and knowledge sharing in the horticulture sector.
MoT	Management of Technology	Master program of the Technical University of Delft.
Mton	Megaton	A unit of mass equal to one million kilograms or 1,000 metric tons.
MVP	Minimal Viable Product	A basic version of a product or service that is developed with the minimum features required to test and validate its viability and potential in the market.
PAR	Photosynthetically Active Radiation	This is the part of the electromagnetic spectrum that plants use for photosynthesis, which includes wavelengths of light between 400-700 nanometers (nm).
SBM(s)	Sustainable Business Model(s)	A business model that aims to create long-term value by balancing economic, social, and environmental factors, and considers the impact of its operations on stakeholders.

SBMC	Sustainable business model canvas	A tool that helps businesses to design and communicate their sustainable business model in a structured and visual way.
SBMI(s)	Sustainable Business Model innovation(s)	The process of creating new sustainable business models or adapting existing ones to respond to changing social, environmental, and economic conditions.
SDG	Sustainable Development Goals	A set of 17 global goals established by the United Nations to address the most pressing social, economic, and environmental challenges facing the world, including poverty, inequality, and climate change.
SIGN	Stichting Innovatie Glastuinbouw Nederland (Foundation for Innovation Dutch Horticulture)	A Dutch foundation that promotes innovation and sustainability in the horticulture sector.
SNM	Strategic Niche Management	A framework for understanding and managing the emergence and diffusion of new technologies or innovations in complex systems.
STN model	Sustainable business model canvas, Tis framework, Niche strategy model	A model made in this study. It connects the SBMC, TIS framework and niche strategies. The model is made to help startups can formulate and implement niche strategies, and see how they can improve the status of the TIS framework and the sustainable business model of the startup.
THB	Thermeleon HeatBattery	A thermal energy storage system that stores and releases thermal energy in greenhouses, made by Thermeleon.
TIS	Technological Innovation System	A specific type of socio-technical systems, encompassing all actors and factors related to a particular technological innovation.
VoD	Valley of Death	A term used to describe the funding gap that early-stage startups often face when transitioning from the research and development phase to commercialization.
WOT	Water OpslagTank (Water buffer tank)	An tank designed to help reduce thermal energy requirements. Often coupled with a heat pump. It holds a circuit of heated water as a means of external thermal energy storage.

1. INTRODUCTION

Sustainable startups play a crucial role in driving the adoption of sustainable innovations and transitioning societies towards sustainable economies (Grant, 2022; Trautwein, 2021). However, the implementation of sustainable business models (SBMs) by these startups often proves challenging, leading to a high failure rate. Globally, only 10 to 20% of startups succeed in making a significant social or sustainable impact. Extensive research has been conducted to understand and address the challenges faced by startups, focusing on various research fields such as the Valley of Death (VoD), Technological Innovation Systems (TIS), and Strategic Niche Management (SNM).

The Valley of Death refers to the difficult phase where startups struggle to fully enter the market, often resulting in their failure (Markham, 2002). Researchers have dedicated considerable effort to understanding the causes of the Valley of Death and finding ways to bridge it successfully (Al Natsheh et al., 2021; Gbadegeshin et al., 2022). Multiple studies have identified a range of barriers that impede startups during the commercialization and market entry process. Emad & Siddiqui (2021) emphasize the importance of industry-specific studies in understanding and addressing these barriers.

Technological Innovation Systems (TIS) involve networks of actors and institutions in a specific technological sector working together to foster the development, distribution, and utilization of technological innovations (Bergek et al., 2015; Carlsson and Stankiewicz, 1991; Markard and Truffer, 2008). Understanding the interactions within a TIS can aid in identifying key barriers to innovation implementation and provide strategies for overcoming them. Ortt & Kamp (2022) developed the TIS framework from a startup perspective to assist startups in implementing their technological innovations and entering the market through niche strategies.

Niche strategies, as described by Schot & Geels (2008), create protected spaces where actors and issues interact. Strategic Niche Management (SNM) aims to establish and control these protected spaces to foster the adoption of promising innovations through experimentation. This involves learning about the desirability of the innovation, building actor networks, aligning interests toward a shared goal, understanding opposing actors' expectations, and fostering institutional expectations. Gbadegeshin (2022) identifies niche strategies as a valuable approach for overcoming the Valley of Death, particularly during the initial market entry of technological startups.

1.1 KNOWLEDGE GAP

Despite the progress made in understanding these aspects, there are notable knowledge gaps that need to be addressed. Firstly, there is a lack of studies linking the TIS framework's startup perspective to research on SBMs or sustainable business model canvas (SBMC), and how this link can help overcome certain startup challenges in implementing niche strategies and addressing innovation barriers. Additionally, there is a gap in the current literature regarding the implementation of sustainable business

models (SBMs) and sustainable business model innovation (SBMI). While previous research has focused on creating and incorporating sustainable and circular business models, limited attention has been given to the methods of implementing these models in the market, often referred to as the design-implementation gap (Baldassarre et al., 2020; Geissdoerfer, Vladimirova, & Evans, 2018). Furthermore, while some studies have examined the factors influencing dynamic changes in a startup's business model, there is a lack of research on how these factors affect the market implementation of SBMs (Kamp et al., 2021; Teece, 2018).

1.2 RESEARCH TARGET

The objective of this thesis is to establish a comprehensive model that provides new insights in connecting studies focusing on the implementation of sustainable business models (SBMs), the Technological Innovation Systems (TIS) framework, and niche strategies. This model aims to provide startups with new insights and tools to formulate niche strategies tailored to their specific circumstances, enabling them to overcome innovation barriers and effectively bring their sustainable innovations to the market while implementing their SBMs.

Subsequently, the developed model will be applied to startups operating in the Dutch horticultural sector to assess its applicability and effectiveness within this specific industry. The choice of the Dutch horticultural sector is motivated by its significance to the Dutch economy as a Topsector, the critical need for sustainable transition within the sector, and the urgency to achieve sustainable targets established by the government. Moreover, considering the sector's current position falling behind the set targets for the present year and potential challenges in reaching the milestones set for 2030, it presents an ideal context for studying the utility of the proposed model.

1.3 RESEARCH QUESTIONS

To address the identified knowledge gap and reach the set research target, the following main research question was proposed;

"How can startups with sustainable innovations overcome barriers by means of niche strategies to implement their sustainable business model in the Dutch horticultural sector?"

To address the main research question, the study is divided into two parts. The first part aims to gain a deeper understanding of the innovation system of the Dhc sector, while the second that is focused on the model which is the research target of this study. The model will need to be constructed, applied and validated to test the utility for general use.

The first sub-question aims to identify the innovation barriers specific to the Dhc sector. It is formulated as follows:

Sub- question 1: *"What are the barriers of the Dutch horticulture innovation system that affect the implementation of sustainable innovations in the sector?"*

To address this question, a qualitative research approach will be employed in this study. Specifically, a combination of literature review and semi-structured interviews with various stakeholders, including current sustainable startups, will be conducted. Initially, the study will identify and describe the different stakeholders involved in the innovation system of the Dhc sector. This analysis aims to gain a deeper understanding of the networks within the Dhc sector and determine which stakeholders from this list should be selected for the semi-structured interviews, thereby providing valuable insights into the innovation system.
Subsequently, a literature review will be conducted to identify the barriers that impact sustainable innovation in the Dhc sector. The semi-structured interviews will serve to validate and supplement the list of barriers identified through the literature review. By incorporating multiple perspectives and considering the specific challenges faced by startups, the study aims to provide a comprehensive and accurate understanding of the barriers to sustainable innovation in the Dutch horticulture sector. The knowledge gained regarding the networks and barriers within this sector will be instrumental for the application of the TIS framework in the later stages of this study.

The second part of this study is namely centered around the model that combined the research studies of SBMs, TIS framework and niche strategies. This study will construct a model for sustainable startups to formulate and implement niche strategies and further develop their business models. Therefore, the second sub-question is proposed:

Sub-question 2*: "What are the key considerations for implementing a model-based approach to help startups adopt effective niche strategies through sustainable business models?"*

To answer this sub-question, a design science approach will be used to develop the STN (SBMC-TIS-Niche) model. This STN model is made from combining the SBMC with the TIS framework and niche strategies. By constructing a model approach, sustainable startups can be guiding in finding appropriate niche strategies and implement them to improve their business models through the sustainable business model. To answer this question, the steps of the model approach will be described and the link between the three individual parts (SBMC, TIS and Niche strategies) will be further described.

To validate the utility of the constructed model and find means for improvement, the model will be applied to current sustainable startups of the sector. As such, the following sub-question is proposed:

Sub-question 3*: "What are the key insights from a case study application of the STN model to sustainable startups of the Dutch horticulture sector?"*

To answer this sub-question, the emphasis is on conducting a case study that applies the newly developed STN model to real-world scenarios. The objective is to explore the practical implementation of the model and analyze the insights and outcomes derived from its application. By studying specific cases of sustainable startups, we can gain

valuable knowledge about the effectiveness and impact of the model in assisting startups with their niche strategies and sustainable business model development.

1.4 RESEARCH OUTLINE

To achieve its objectives and answer the research questions, this study will follow a structured approach commonly used in scientific research. The Research Flow Diagram (Figure 1.1) illustrates describe the steps that will be taken to answer the research questions.

Chapter 1 provides an introduction to the research questions and the outline of this thesis. Chapter 2 will the methodology used to answer the research questions. In Chapter 3, the existing literature on Technological Innovation Systems studies, Strategic Niche Management studies, and Sustainable Business Model Innovation studies will be reviewed to provide the necessary background information.

Chapter 4 will present the research findings on the innovation system and innovation barriers of the Dutch horticulture sector to answer sub-question 1. Chapter 5 answer the second sub-question by providing a tool for sustainable startups to formulate and implement niche strategies. This chapter will describe the formation of the STN model. A detailed description of the STN model will be provided in Appendix 3. Chapter 6 describes the application of the STN model to the two case studies startups. The observations and learnings from this application are discussed in Chapter 7 along with the feedback obtained from the startups.

A further discussion of all research findings and methods is done in Chapter 9. Chapter 10 will serve as the conclusion of this thesis, providing a summary of the main findings and addressing the research questions based on the results obtained from the study. Furthermore, the contributions of this study to the field will be highlighted in this chapter. Lastly, Chapter 11 will provide a reflective analysis of the study, discussing the assumptions and limitations of the research and providing recommendations for future research.

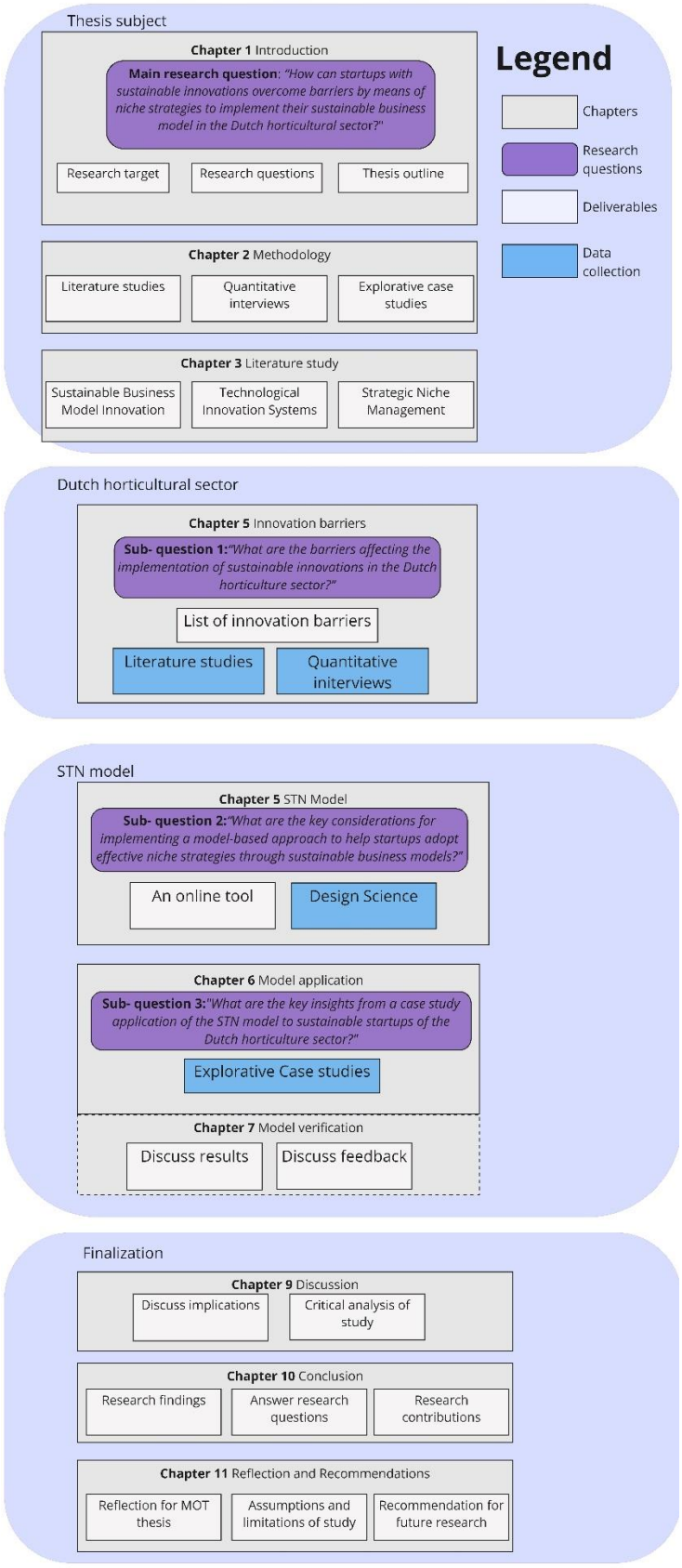

Figure 1.1 Research Flow Diagram.

1.5 STUDY FIT

This thesis is written to finalize the master Management of Technology (MoT) at the Technical University of Delft. As such, the research objective should follow the vision of the master program. According to the MoT study director, MoT focuses on the combining engineering with business knowledge, to design and implement technology-based solutions to commercial and social problems (Verburg, 2017). The objective of this thesis is to formulate a new model that can help startups implement their innovations and business models in the Dutch horticulture sector. Since implementation of startup innovation is central to this proposal, it is in line with the core vision of the master program.

2. METHODOLOGY

This chapter describes the types of research methods used to answer the research question and sub-questions.

2.1 LITERATURE REVIEW

The first step in this research was to conduct a qualitative literature review. Literature review provides a comprehensive understanding of the existing knowledge and research in a particular field. Qualitative literature reviews bring together research on a topic, searching for research evidence from previous studies and drawing the findings together in perhaps a novel way (Seers, 2015). The literature review for this research was conducted to analyze the stakeholders of the Dutch horticultural sector and to study what past researchers found regarding innovation barriers in the sector (sub-question 1).

To answer sub-question 1, data from diverse studies with various samples sizes, study methods from varying countries needed to be compared and combined into one list. To achieve this, a systematic approach was taken to identify the barriers and evaluate their likelihood of affecting growers or startups in the Dutch horticultural sector. Here, the sectors most closely related to the Dutch horticulture (e.g. German horticulture) were evaluated first and other sector less relatable were compared later (e.g. Israel horticulture). This approach involved evaluating the similarities and differences between the findings of previous studies and the current research focus, which helped in determining the validated barrier list. For barriers based on legislative situation of other countries, these were excluded. To check the validity of the barrier list, semi structured interviews were conducted with stakeholders of the Dutch horticultural sector.

2.2 THE SEMI STRUCTURED INTERVIEWS

Semi-structured interviews were conducted with stakeholders of the Dhc sector's innovation system to gain better insight into the barriers affecting the implementation and distribution of sustainable innovations in greenhouses of growers (sub-question 1). While the literature review revealed that previous studies had mostly focused on interviews with growers, it was recognized that other stakeholders were also important in the technological innovation system of the Dhc sector, including sustainable startups, grower associations, innovation institutions, knowledge institutions, and sustainability institutions. To ensure a comprehensive understanding of the barriers from different perspectives, the objective was to interview at least three organizations per major stakeholder group, with a special focus on the growers since they are the main contributor to the environmental strain of the sector.

The selection of the parties within these stakeholder groups was based on market size, and all parties with the most influence in the market were contacted to plan the interviews. However, some parties did not want to participate or did not respond to emails, resulting in only the willing parties being interviewed. Due to varying

circumstances, not all interviews were conducted in the same way. The interviewer adapted to each interviewee's preferences to maximize the number of actors that could be interviewed for this study. The interviews were conducted through three formats: phone, online meetings, and face-to-face meetings. The researcher aimed to conduct at least one face-to-face interview with an actor from each stakeholder group to maximize the information that could be obtained from the interview. Ultimately, the stakeholder groups that were interviewed were the growers, sustainable startups, and innovation system experts, which included innovation institutions, knowledge institutions, and governmental institutions promoting sustainability in the Dhc sector.

2.3 MODEL FORMATION

The STN model was created using the visual online program called Miro. In this program the existing SBMC, TIS framework and niche strategies from literature were visually constructed. The connections between these components were established based on the descriptions provided for each element on the canvas, framework, or strategies.
Initially, the TIS framework was connected to the SBMC by linking the individual TIS building blocks to the individual parts making up the SBMC. This connection was made systematically for each part of the SBMC, ensuring that the relevant TIS building blocks were properly aligned. A comprehensive description of this process, along with the rationale behind each connection, is outlined in Appendix 3.
Subsequently, the same approach was followed for each individual niche strategy. Each niche strategy was connected to the corresponding TIS building blocks and SBMC components, taking into account the specific descriptions provided by Ortt et al., (2013). In Appendix 3, a detailed account of these connections and their underlying reasoning is provided.

2.4 MODEL APPLICATION

To assess the utility and validity of the STN model, exploratory case studies were conducted. Startups were selected based on specific criteria, namely having a technological innovation that can enhance the sustainability of greenhouse production, with the grower as the end user of the product. Additionally, these startups should have already approached clients for the purpose of selling or validating their product, as this would provide valuable insights into the challenges faced during market introduction. In order to make the study applicable to future startups, a diverse range of sustainable innovation types were included in the case studies.
For this study, two sustainable startups were chosen, each representing a different type of innovation. One startup, Thermeleon, focused on energy savings, while the other startup, FOTONIQ, concentrated on optimizing the use of natural resources and improving production and quality. The TIS framework was applied to these startups using the method outlined in section 2.3.1. Subsequently, niche strategies were formulated in section 2.3.2 to address the barriers identified within the TIS framework. To validate the niche strategies and the STN model in this study, the approach as described in section 2.3.3 was used.

2.4.1 TIS WORKSHOPS

To gain insight into the status of the TIS building blocks and influencing factors for each startup, it was important to involve core team members who had an intimate understanding of their company's operations. However, these members may not have had the necessary knowledge of the TIS framework to utilize it effectively within the scope of this study. To address this, a TIS workshop was organized with selected members from each startup. For Thermeleon, the founders and core team members attended, while for FOTONIQ, the strategic director participated. Prior to the workshop, each participant was provided with a document (Appendix 5) that briefly explained the TIS framework. During the workshop, the participants were guided to describe their views on each building block and influencing factor. The researcher provided key points of interest for each part, based on the detailed explanation of Ortt & Kamp (2022). Finally, the participants formulated their conclusions on the status of each block and factor based on their collective input.

2.4.2 NICHE STRATEGY FORMULATION

The next step in the STN model involves developing effective niche strategies for the startups based on the status of the TIS framework. These strategies were designed to address the identified hindering building blocks. Additionally, the connection between the TIS building blocks and the SBMC was utilized to formulate niche strategies that also enhance the components of the SBMC. Consequently, the impact of the niche strategies can be traced to the sustainable business models of the startups. The startups were requested to provide information on past niche strategies, enabling the incorporation of these findings into a timeline that is linked to their business models.

2.4.3 VALIDATION

The final step of this study aims to validate the STN model through the assessment of its practical application and the qualitative feedback obtained from the case study startups. This feedback will be instrumental in further improving the STN model. Detailed feedback has been documented in Appendix 2. The startups were specifically asked to provide feedback on the insights gained from the comprehensive descriptions of the STN model's applications (see Appendix 5). In Chapter 7, the feedback provided by the startups will be thoroughly discussed. This discussion will encompass means of improving the model and provide valuable insights for future studies.

3. LITERATURE REVIEW

This chapter provides a comprehensive overview of the theoretical foundation of sustainable business models, sustainable business model innovations, technological innovation systems and niche strategies. This knowledge will form the basis for the rest of this thesis report and the formation of the STN model described in Chapter 8. The purpose of this chapter is to expand on the research background presented in the introduction, with the aim of assisting startups with sustainable innovations in overcoming the valley of death through niche strategies. To fully understand these implications, it is necessary to have a solid background in sustainable business model innovations, technological innovation systems, and strategic niche management.

3.1 BUSINESS MODELS

Over the years, the concept and usage of business models have undergone several changes (Geissdoerfer, Vladimirova, & Evans, 2018; Nosratabadi et al., 2019). Originally, business models were used to communicate complex business ideas with potential investors (Zott et al., 2011), but later became a tool with multiple uses aligned for systemic analysis, planning, communication, and implementation of organizational units, competitive advantage, and firm performance. In a review conducted by Geissdoerfer et al., (2018) various definitions of business models were presented. Business models revolve around value, categorized as Value Proposition, value creation, value delivery and value capture (Richardson, 2008). In this report, the definition proposed by Geissdoerfer et al., (2018) will be used. They defined business models as *"simplified representations of the Value Proposition, value creation and delivery, and value capture elements and the interactions between these elements within an organizational unit"* (Geissdoerfer, Vladimirova, & Evans, 2018, p. 402).

3.1.1 BUSINESS MODEL INNOVATION

Business model innovation refers to changes in the configuration of a business model, either as a whole or individual parts. Successful implementation of BMI can increase a company's ability to adapt to market changes and increase its resilience as a competitive advantage (Mitchell & Coles, 2003). As a result, most of the application of BMI has been in corporate diversification, business venturing, and start-up contexts (Geissdoerfer, Vladimirova, & Evans, 2018). Geissdoerfer and colleagues (2018) identified four configurations of BM, namely start-ups, business model transformation, business model diversification, and business model acquisition.

The definition of what change to a business model constituted as BMI has been subject to some discussion (Geissdoerfer, Vladimirova, Fossen, et al., 2018). For this study, the definition of business model innovation was chosen as described by Geissdoerfer et al., (2016).*"Business model innovation describes either a process of transformation from one business model to another within incumbent companies or after mergers and acquisitions, or the creation of entirely new business models in start-ups"* (Geissdoerfer et al., 2016; p. 1220).

3.1.1 BUSINESS MODEL CANVAS

The Business Model Canvas (BMC), introduced by Osterwalder & Pigneur (2010), is a visual representation of the elements of a business model. The BMC has been widely used by both practitioners and researchers (Joyce & Paquin, 2016; Massa & Tucci, 2013). The BMC divides the value categories of the BM into 9 interconnected parts called "the 9 building blocks," namely Value Proposition, Customer Segments, Customer Relationships, Channels, Key Resources, Key Activities, key partners, costs, and revenues (Osterwalder & Pigneur 2010. p16). Value Proposition remains undivided, value creation is done by Key Resources, Key Activities, and key partners, value delivery is subdivided into Customer Segments, Channels, and customer relations, and value capture consists of revenues and costs (Figure 3.1).

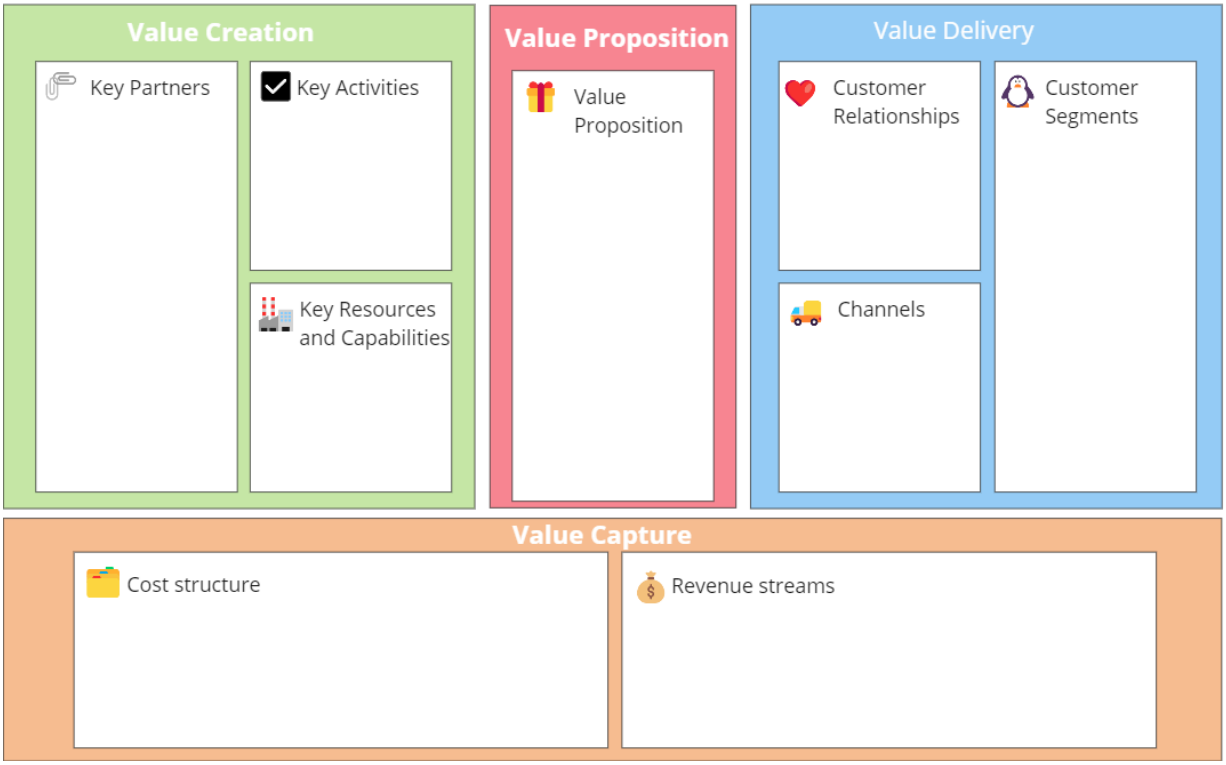

Figure 3.1 Business Model Canvas (adopted from Osterwalder & Pigneur, 2010).

Despite its popularity, the BMC has been subject to several criticisms and limitations (Ching & Fauvel, 2013). One issue is the exclusion of external forces to a business model, such as competition, market factors, and other external forces. Another limitation is the narrowness of the Value Proposition, as the focus is on creating value with revenue on return, excluding other purposes of organizations such as nonprofit and governmental organizations. Additionally, the separation of Key Activities and Key Resources implies a higher level of detail about what the organization needs to do to create its Value Proposition, which may not be consistent across all building blocks. Other limitations include the lack of mechanisms between the individual building blocks, and the need for team cooperation and storytelling to create these mechanisms. Despite these limitations, the BMC remains a popular tool for entrepreneurs to describe their business ideas, and any addition or revision to the model can aid new startups in their future endeavors.

3.1.1 SUSTAINABLE BUSINESS MODEL INNOVATION

Sustainable business model innovation (SBMI) combines elements of business model innovation with sustainability considerations (Geissdoerfer, Vladimirova, & Evans, 2018). It comprises the conceptualization and implementation of sustainable business models, which can be the development of entirely new business models, diversification into additional business models, acquisition of new business models, or transformation from one business model to another. SBMI is a subset of the SBM field, which is relatively recent. There are four types of SBMI: sustainable startup, sustainable business model transformation, sustainable business model diversification, and sustainable business model acquisition (Geissdoerfer, Vladimirova, & Evans, 2018). These aim to implement SBMs by using one of the nine sustainable business model archetype strategies (Bocken et al., 2014; Ritala et al., 2018). For this study, startups of the technological sub-grouping of the nine archetypes will be used for the case study example. Startups belong to this grouping will aim to increase the sustainability of the Dhc sector using a technological innovation which can be assessed using the TIS framework of Ortt & Kamp (2022). Under the technological grouping, the archetypes are; (1) maximize material and energy efficiency, (2) closing resource loops and (3) substitute with renewables and natural processes.

However, there is still a research gap in the SBMI field, specifically the design-implementation gap, which refers to the challenges that prevent organizations from successfully innovating their business model due to insufficient follow-up on ideas, lack of implementation of concepts, and failure of businesses in the market (Evans et al., 2017; Geissdoerfer, Vladimirova, & Evans, 2018; Ritala et al., 2018). This closely resembles the VoD as previously described, especially the part regarding the failures of businesses in the market. While the BSM model aims to overcome the VoD, as described by Gbadegeshin et al., (2022), it might not be used to overcome the design-implementation gap. What could be useful are the niche strategies to reduce the risk of market implementation of the SBMI concepts. To find the right niche strategies, the TIS framework could be utilized and their effects on SBMs will be further explored in this study.

Baldassarre *et al.,* (2020) proposed a tool specific to SBMI to overcome the design-implementation gap, which involves prototyping or constructing small-scale pilots. This resembles the implementation of a specific niche strategy (Demo and experimentation niche, Table 3.1). However, more research is necessary regarding the implementation of SBMI. Minatogawa *et al.,* (2022) proposed that SBMI can learn from BMI since the latter is more explored. This study, argues that implementation of SBMI could be aided by niche strategy management studies or the TIS framework to reduce the risk of failure and to find appropriate strategies respectively.

3.1.1 SUSTAINABLE BUSINESS MODEL

Sustainability in the business-oriented context is mostly represented by multi-stakeholder "triple bottom line" (people-planet-profit) (Elkington, 1998; Stubbs & Cocklin, 2008). SBMs are a more recent concept, specifically from this last decade (Ritala *et al.,* 2018). The main purpose of the SBMs' first conception was to put companies into a more sustainable

economic system and to help their sustainable ambitions. Currently, SBMs are seen more as a source of competitive advantage (Nidumolu, 2009), which might become more present in the current economic inflation. Geissdoerfer and colleagues (2018) listed the definitions for SBMs found in literature, and observed that they see SBMs as a modification of conventional BM concepts with added goals or characteristics. Sustainability was either integrated into the Value Proposition, value creation and delivery, or value capture parts, or sustainability was seen as a goal.

3.1.1 SUSTAINABLE BUSINESS MODEL CANVAS

The sustainable values were incorporated into the widely-used BMC forming the sustainable business model canvas (SBMC) (Bocken et al., 2018). The SBMC includes social, environmental, and financial indicators of value in the Value Proposition segment (Figure 3.2). Another method to incorporate sustainable values into the BMC was developed by Joyce & Paquin (2016) in the form of the triple layer business model canvas. While the BMC and SBMC share nine building blocks, the SBMC places a greater focus on creating and delivering social and environmental value in addition to economic value. However, this expanded focus may lead to conflicts of interest among stakeholders. Additionally, a potential issue with the SBMC is that the Value Proposition may not be tailored to the correct market segment, as the problem being solved may be for society or the environment rather than the customer. This will be elaborated upon more in Chapter 5, as this was also found during the interviews.

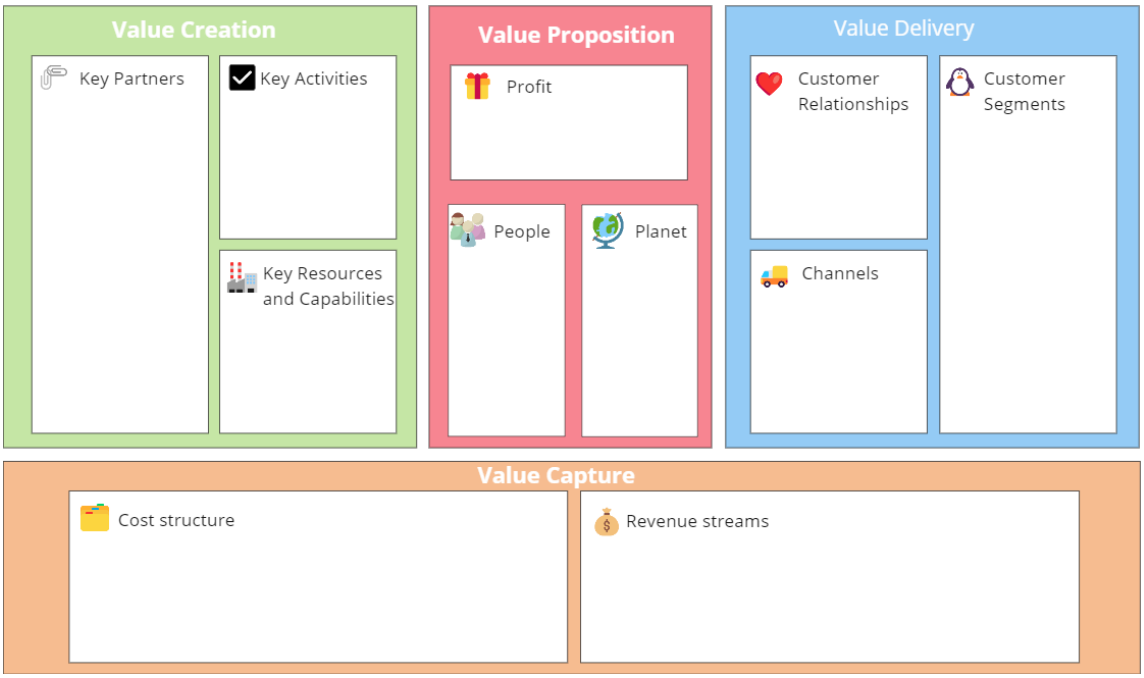

Figure 3.2 Sustainable Business Model Canvas (adopted from Bocken et al., 2018).

3.2 TECHNOLOGICAL INNOVATION SYSTEM

Technological innovation systems (TIS) are a specific type of socio-technical systems, encompassing all actors and factors related to a particular technological innovation (Carlsson & Stankiewicz, 1991). Studies regarding TIS focus on the interplay between various actors, such as firms, universities, research institutes, regulatory bodies, and customers, in the development, diffusion, and utilization of new technologies (Geels, 2004; Ortt & van der Duin, 2008).

The TIS framework sheds light on the dynamics and evolution of technological innovations and the role of different actors in this process (Carlsson et al., 2010; Carlsson & Stankiewicz, 1991). Malerba (2002) identified four structural components of the TIS framework: technology, a network of actors, supporting institutions, and a demand side. In this study, three of these four components will be studied by stakeholder analysis. Studies have also focused on TIS performance to identify shortcomings and provide recommendations for policymakers to support the implementation of specific technologies (Alkemade et al., 2011; Jacobsson & Karltorp, 2013; Wieczorek & Hekkert, 2012).

In the context of sustainable transitions, policies are often considered necessary because the free market behavior of companies in existing markets does not always favor sustainable innovations (Kemp et al., 1998). Therefore, public policies are needed for the market to shift to more societally desirable, sustainable, solutions. This is similar to what we have seen in the Dhc sector as legislative actions are taken by the European, National and Regional governmental (macro-level) bodies to increase the transition towards sustainable innovations.

However, despite such policies, entrepreneurs at the micro-level are still required to find and develop sustainable innovations. Moreover, despite the formulated policies, there may still be barriers hampering the implementation and market entry of sustainable innovations. From the startup perspective, these challenges and barriers are often grouped under the term "Valley of Death" (Al Natsheh et al., 2021; Markham et al., 2010). Overcoming this valley entails managing to make a sustainable business, such that the startup's commercial sales cover their costs. Several studies have focused on ways to overcome the Valley of Death, with niche strategies being mentioned specifically for the initial market entry of technological startups (Gbadegeshin et al., 2022).

3.3 STRATEGIC NICHE MANAGMENT

Strategic niche management (SNM) is a tool for guiding technological innovations towards transforming the existing system, as noted by (Kemp et al., 1998). According to Schot & Geels (2008), niches are protected spaces where interactions between issues and actors take place. SNM aims to create, develop, and control protected platforms for the adoption of promising innovations via experimentation, which involves learning about the desirability of the innovation, building actor networks, aligning interests to a shared goal, identifying opposing actors' expectations, and fostering institutional expectations.

SNM is not limited to one type of actor and can be used by various groups of people, including states, policy makers, regulatory agencies, NGOs, citizen groups, and private companies. The purpose of SNM is to either develop socially desirable innovations serving long-term goals such as sustainability and/or manage radical novelties misaligned with existing infrastructure, user practices, regulations, etc.

Caniëls & Romijn (2008) emphasize that SNM aims to contribute to a broad shift towards more sustainable economic development through an integral combination of technological progress and system-wide social-institutional changes. They note that potentially useful sustainable technologies often fail to be fully developed or catch on in the market, despite promising superior performance compared to incumbent technologies. SNM can help to provide insights into the nature of these obstacles and guidance to overcome them.

3.4 THE TIS FRAMEWORK

Ortt & Kamp (2022) developed a TIS framework tailored specifically for entrepreneurs to help manage their innovations. In this study, the framework will be used to guide sustainable innovations into the Dhc sector market. The framework is made to take the company perspective and analyze the status of a new innovation and formulate niche strategies to enter the market. The framework expands on previous studies that defined four structural components of a TIS (Malerba, 2002) and three factors of effect (Geels et al., 2008) into seven building blocks and influencing factors. By assessing the status of all these 14 units, a niche strategy can be formulated (Ortt & Kamp 2022).sub

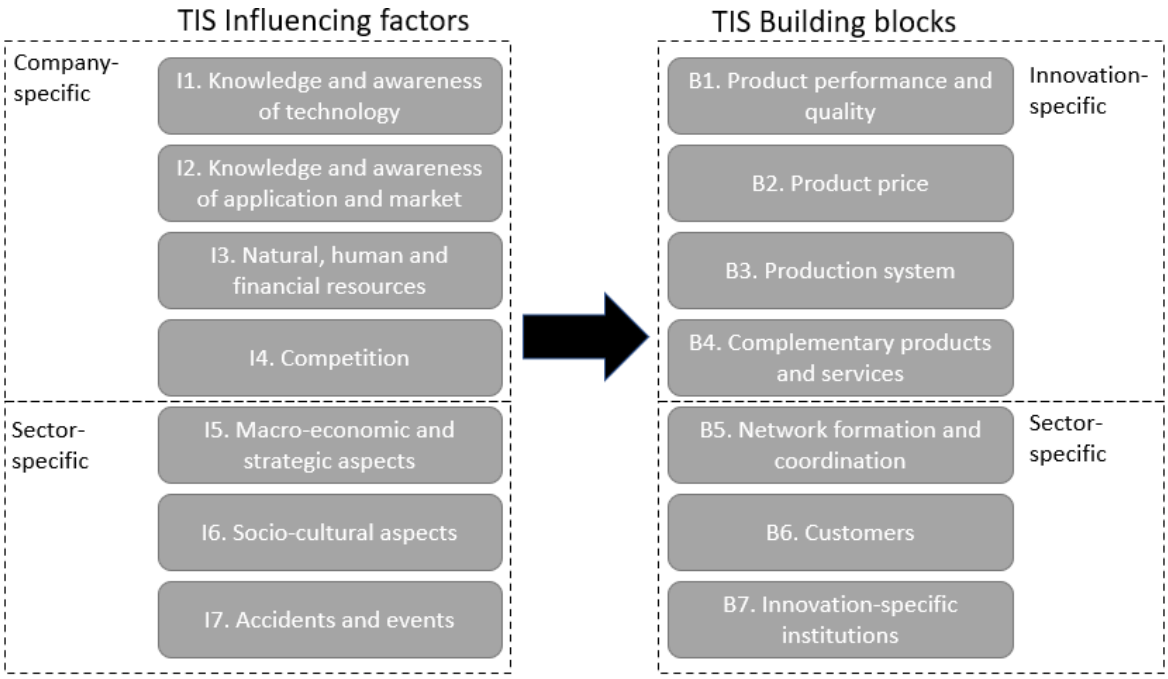

Figure 3.3 Technological Innovation System (TIS) framework (adapted from Ortt & Kamp, 2022).
Seven building blocks sub-divided in innovation- and sector-specific blocks as originally presented by Ortt et al., (2015) with seven influencing factors, also sub-divided into company- and sector-specific (adapted from Ortt & Kamp, 2022).

3.4.1 SEVEN TIS BUILDING BLOCKS

The TIS framework consists of seven building blocks, which were expanded from four components of a TIS; technology, a network of actors, supporting institutions, and a demand side (Malerba, 2002). These building blocks form the foundation of the TIS framework and can present barriers to large-scale diffusion. The technology component is further subdivided into product technologies, the product itself, and Complementary products and services (as shown in Figure 3.3).

For this study, the seven building blocks are divided into two categories: the innovation-specific part and the sector-specific part. The former includes Product Performance and Quality (B1), Product Price (B2), Production Systems (B3), and Complementary products and services (B4), which are areas that a company can directly affect. The latter includes Network formation and coordination (B5), Customers (B6), and Innovation-Specific Institutions (B7), which are areas that a company has little to no direct effect on.

It is essential for companies to understand which building blocks they can impact and which they cannot impact as easily to improve their chances of successful market entry. Therefore, in this report, we will frequently refer to these seven building blocks by their name or block number, such as B1 for Product Performance and Quality.

B1. Product Performance and Quality

The performance and quality of the product should be high enough to attract customers and make them consider it as a viable option. This is particularly important for sustainable innovations, as the early versions of the product with low quality may not meet customers' requirements, hampering large-scale diffusion (Kemp et al., 1998).

B2. Product Price

Product Price is an important TIS building block. Often, technological innovations are initially very expensive compared to competitive alternatives, which can hamper their diffusion (Kemp et al., 1998). For large-scale diffusion, a product is required with a reasonable price (absolutely or relatively compared to other competitive products) (Negro et al., 2012).

B3. Production System

For large scale diffusion, a Production System with high production capacity is very important. However, for radically new innovations, this building block will likely be incomplete or absent. The construction of a production facility is a big investment that startups will be unlikely to develop in early stages.

B4. Complementary products and services

The availability of Complementary products and services can greatly improve the diffusion of the innovation. These products aid sales since the procurement of one, increases that of the other. If there are no such products or services, then the diffusion of the innovation will be reduced (Geels, 2004; Kemp et al., 1998).

B5. Network formation and coordination:
The fifth TIS building block is the network of actors in the supply chain. The actors of the innovation systems can refer to any company that is part of the supply chain, such as the suppliers, distributors or producers of the innovation or Complementary products and services (Kamp & Vanheule, 2015; Kemp et al., 1998). If there is a lack of actors or a lack of coordination between them, large-scale diffusion is blocked.

B6. Customers
The customers are an important TIS building block, since without customers, no large-scale diffusion is possible. The identification of potential future customers should be done in early stages of the startup. When innovations are developed without involving (future) customers, several customer-related issues may hamper their diffusion (Kamp et al., 2004). Customers need to adopt the new technologies and integrate them into their daily practices (Geels, 2004). This is something businesses need to be mindful of, manage or even improve to ensure that large scale diffusion is possible.

B7. Innovation-specific institutions
Finally, the last TIS building block is formed by the innovation-specific institutions. These are the set of formal and informal rules affecting the innovation, such as governmental policies, laws or standard practices (Ortt & Kamp, 2022). These institutions can either aid or block the innovation.

3.4.1 SEVEN TIS INFLUENCING FACTORS

The TIS framework not only includes the seven building blocks but also introduces seven influencing factors that help to understand why and how these building blocks can impede large-scale diffusion of an innovation. These influencing factors are derived from three main groups of influences, namely knowledge, resources, and macro-environmental conditions, as described by (Geels et al., 2008).

For this study, we make a distinction between company-specific factors and sector-specific factors. The company is more responsible for knowledge and resources, whereas macro-environmental conditions are factors that are outside the company's sphere of influence and are more closely related to either sectoral or larger spheres of influence. Therefore, the influencing factors are split into two categories (Figure 3.3). The first category includes company-specific factors: Knowledge and awareness of technology (I1), Knowledge and awareness of application and market (I2), Natural, human, and financial resources (I3) and Competition (I4). The second category includes sector-specific factors: Macro-economic and strategic aspects (I5), Socio-cultural aspects (I6), and Accidents and events (I7).

Throughout this report, we will frequently refer to these seven TIS influencing factors by name or by their corresponding influencing factor number, such as I1 for Knowledge and awareness of technology.

I1. Knowledge and awareness of technology

This factor refers to the understanding of the principals involved in the components of the TIS, such as product, production, and complementary products and services. It includes fundamental and applied technological knowledge that can be developed through research and development, education, and training.

I2. Knowledge and awareness of application and market

This factor refers to the knowledge of how and where the innovation can be used and the market structure, including the relevant actors involved. It includes market analysis, experimentation, and learning by doing or interacting with relevant actors in the socio-technical system.

I3. Natural, human, and financial resources

This factor refers to the availability of resources required to create products, Production Systems, and complementary products and services. It includes natural resources, human resources with appropriate knowledge and competencies, and financial resources from different types of actors.

I4. Competition

This factor refers to the competition between different product versions based on a new technology or competing alternatives that require different components, Production Systems, complementary products, and services. It can create a complex pattern of competition between networks of companies, increasing uncertainty.

I5. Macro-economic and strategic aspects

This factor includes the macro-economic conditions such as the market structure and the contemporary way of doing business and strategic policies of countries regarding important industries. It can influence the formation of TIS building blocks, with economic recession hampering TIS formation and economic growth facilitating it.

I6. Socio-cultural aspects

This factor refers to the norms and values held by potential customers and other important stakeholders in the socio-technical system, which can influence the formation of TIS building blocks. It includes informal aspects that can change over time and can switch from a stimulating to a blocking factor.

I7. Accidents and events

This factor refers to accidents within the TIS, such as accidents during the production process or natural disasters, that can affect the formation of TIS building blocks.

3.4.2 NICHE STRATEGIES AND THE TIS FRAMEWORK

The convergence of TIS and SNM is particularly relevant for technological startups looking to enter the market. By identifying obstacles in the innovation system, TIS can help entrepreneurs employ niche strategies to overcome them. To help entrepreneurs better manage their innovations, the TIS framework of Ortt & Kamp (2022) can be used. Based on the status of the seven building blocks and seven influencing factors, niche strategies can be derived (Table 3.1). These niche strategies are chosen from the earlier work of Ortt et al., (2013), where ten niche strategies were presented (Table 3.1). The niche strategies can help startups overcome the barriers and are thus important for market entry and upscaling (Ortt et al., 2015). Table 3. 1 also describes when a particular niche strategy should be implemented. Note that the combination of the status of the influencing factor and building block is needed for a startup to find an appropriate niche strategy.

Table 3.1 Ten niche strategy descriptions with implementation circumstance (Ortt et al., 2013).

Generic niche strategies	**Description of the niche strategy**	**Implement based on TIS situation**
1 Demo, experiment and develop niche strategy 	For this niche strategy the product is showcased to a specific audience in a controlled setting, minimizing performance or quality limitations. Experimenting is a vital part of this strategy to develop the product further.	• Lacking Knowledge of tech (I1) affects Product quality (B1)
2 Redesign niche strategy 	A product redesign strategy can improve market fit by simplifying production or adapting it to a different application. A niche strategy can be adopted to introduce a simpler version of the product, leveraging existing knowledge and resources to reduce costs. The niche strategy can also involve exploring an application with more favorable institutional or market conditions that may require product redesign.	• Lacking Knowledge of tech (I1) affects the Product Price (B2) or Production System (B3) •Lacking Resources (I3) affects the Product Price (B2) or Production System (B3) •Lacking Knowledge of appl (I2) affect Product quality (B1) •Hindering Socio-cultural aspects (I6) aspects affect Institutions (B7) (e.g. laws, rules and standards) • Hindering Socio-cultural aspects (I6) affect the availability of Networks (B5) or Customers (B6)
3. Stand-alone niche strategy 	A niche strategy to use the product as a standalone or integrated with complementary products and services. The strategy can for example adopt a local network where infrastructure is limited.	•Lacking Knowledge of tech (I1) affects Complements (B4) •Lacking Resources (I3) affects Complements (B4)

4. Hybridization or adaptor niche strategy 	A niche strategy to use the product in combination with existing products, leveraging complementary products and services. This strategy can for example be used to reuse all existing complementary products and services, or provide an adapter/convertor to make the product compatible.	•Lacking Knowledge of tech (I1) affects the Complements (B4) • Lacking Resources (I3) affects the Complements (B4)
5. High-end niche strategy 	A niche strategy can be adopted to produce hand-made products in small numbers for a specific high-end market segment. Products can be made to order for the top niche of customers with a special product, to maximize returns (skimming strategy).	• Lacking Knowledge of tech (I1) affects Product Price (B2) • Lacking Knowledge of tech (I1) affects Production System (B3) • Lacking Knowledge of tech (I1) affects Product quality (B1)and Product Price (B2) • Lacking Resources (I3) affects Product Price (B2)
6. Educate niche strategy 	A strategy to transfer knowledge of the technology to the suppliers or customers.	• Lacking Knowledge of tech (I1) affects the availability of supply Networks (B5) or Customers (B6)
7. Lead user niche strategy 	A niche strategy can be used to find innovators or lead users who can co-develop a product and experiment with it. This strategy enables firms to learn about suitable designs, as expert users are highly involved in developing the product further.	• Lacking Knowledge of appl (I2) affects the Customers (B6) • Hindering Socio-cultural (I6), Macro-Economic aspects (I5) or Accidents (I7) affect Networks (B5) • Hindering Socio-cultural (I6), Macro-Economic aspects (I5) or Accidents (I7) affect Customers (B6).
8. Explore multiple markets niche strategy 	A niche strategy can be adopted to explore multiple customer applications and find successful ones through trial and error. Visibility of the first applications can stimulate explorative use in new applications.	• Lacking Knowledge of appl (I2) affects the Product quality (B1) and Customers (B6)
9. Subsidized niche strategy 	A niche strategy can be adopted to subsidize the product development using public funds if the use of product by a particular segment of users is considered societally relevant.	• Lacking Knowledge of tech (I1) affects the Product Price (B2) or Production System (B3) •Lacking Resources (I3) affects the Product Price (B2) or Production System (B3)

10. Geographic niche strategy 	A niche strategy can be adopted to move the product launch to a more favorable geographic area based on local or regional characteristics such as institutions, resources, suppliers, or customers.	• Knowledge of tech (I1) affect the Institutions (B7) (e.g. laws, rules and standards) • Resources (I3) affect Product quality (B1) or Complements (B4). • Hindering Socio-cultural (I6) or Macro-Economic aspects (I5) affect Networks (B5), Customers (B6) or Institutions (B7) • Accidents (I7) affect the availability appropriate Institutions (B7)

Once implemented, these niche strategies will affect the company's situation. The change in the status of the building blocks should therefore be closely monitored by the business leaders to see when changes are needed. The strategies not only affect the TIS building blocks, but can also the business model of a company. To understand how, the a the STN model was constructed where the connection between the SBMC, TIS framework and Niche strategies visualized.

4. THE DHC SECTOR

In this chapter, we will discuss the stakeholders involved in the supply chain of the Dhc sector and describe some of the barriers that hamper the implementation of sustainable innovations. This knowledge can help asses status of the sector related building blocks and influencing factors of the TIS when applying the TIS framework and STN model to the case study startups. Additionally, this will prove some background knowledge of the sector.

4.1 STAKEHOLDERS OF THE DHC SECTOR

This section provides an overview of the stakeholders involved in the supply chain of the Dhc sector. The supply chain encompasses organizations that participate in the production and sale of products, covering everything from 'seeds to plate'. We can distinguish between the supply chains for food (fruits and vegetables) and non-food (flowers, trees, and pot plants) products (see Figure 4.1). This section will explore a brief history of the sector, discuss current trends and events within the Dhc sector supply chain, and provide background information on the sector. Additionally, we will examine the interactions between certain stakeholder groups and highlight potential barriers to innovation arising from these interactions. In Appendix 4, a more detailed description of each stakeholder group is provided. This appendix also includes political and innovation institutions in the stakeholder analysis of the Dhc sector.

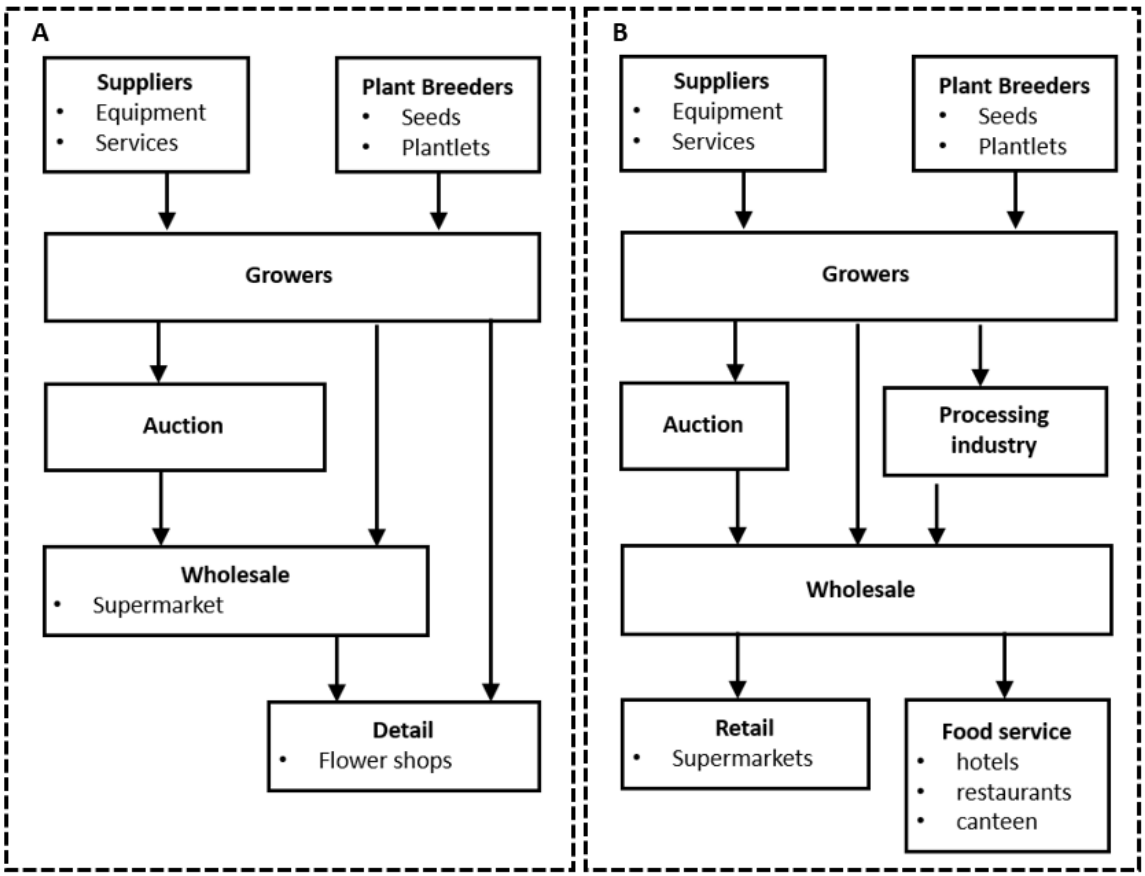

Figure 4.1 Production chain for food and non-food.
On the left (A) the production chain of non-foods is displayed in the Dutch horticulture based on (Berkhout et al., 2022). The right (B), displays the produciton chain of foods (Jukema et al., 2020).

Historically, the Dutch horticulture market consisted of a small group of seed companies supplying a large number of growers with seeds. These growers would then bring their products to auction, where food items were sold to wholesalers and retailers before reaching consumers (Breukers et al., 2008; Vijverberg et al., 2007). However, the landscape began to change in the 1980s with the emergence of supermarket chains, leading to a decline in auction houses. To remain competitive, smaller auction houses merged, and growers formed grower associations to regain some influence in the production chain (Breukers et al., 2008; Vijverberg et al., 2007). Presently, only a few food wholesale companies have significant buying power, while numerous growers are compelled to compete for the lowest prices to sell their products (Franck & Nemes, 2017). As a result of this power imbalance in the supply chain, growers are pursuing vertical chain integration, including plant breeding, growing, and selling in their process (Schoormans & Rabensbergen, 2022).

Supermarkets are the primary beneficiaries of this power imbalance in the supply chain. The two largest supermarket chains, Albert Heijn with 35.3% market share and Jumbo with 18.7% market share, enjoy the most advantages (Franck & Nemes, 2017). Oxfam International has highlighted that supermarkets take around 43.8% of the profit margins of the products sold, while growers receive only 7.8% (Franck & Nemes, 2017; Willoughby & Gore, 2018). The next section (Subchapter 5.2) will explain how this power dynamic significantly hampers the adoption of sustainable innovations by growers.

Despite the influence of supermarkets, the Dutch flower industry remains dominated by auction houses (Schoormans & Rabensbergen, 2022; Wijnands, 2005). In facts, the Dutch auctions serve as the largest global marketplace for flower trade, solidifying the country's position in the floriculture industry (Jukema et al., 2020). From the actionhouses, the flowers are sold mainly through flower shops, while some are also sold online, through supermarkets and itinerant trade, such as markets. Flower shops, specializing in occasions like weddings and funerals, sustain their market share despite a decline in numbers (Jukema et al., 2020; Berkhout et al., 2022). Garden stores are popular for pot plant purchases, holding a 30% market share, while supermarkets and flower shops each account for 20%. Online sales constitute around 12% of pot plant purchases (Berkhout et al., 2022).

Consumers play a vital role as the ultimate stakeholders in the production chain. With a growing awareness of their impact on sustainable production, they are shifting towards meat-replacing products, fruits, and vegetables (NAGF, 2019; NOS, 2019). The National Action Plan for Vegetables and Fruit (NAGF) employs subtle nudges to encourage such consumption (NAGF, 2019). Increased awareness of sustainability labels has driven the consumption of sustainable foods from 8% in 2013 to 19% in 2021 (Logatcheva, 2022). Collaborating with labels like *"Rainforest Alliance"* and *"On the way to Planet Proof"* can enhance the market position of sustainable startups, incentivize growers to adopt sustainable innovation, thought targeted consumption of sustainable products.

4.2 INNOVATION BARRIERS IN DHC

In this sector, we provide a comprehensive overview of the barriers that hinder the implementation of sustainable innovation in the Dhc sector, which is outlined in Table 4.1. To accomplish this, we have utilized information from both the existing literature and insights gathered through interviews with key stakeholders including growers, sustainable startups, and sector experts. By incorporating the perspectives of these diverse stakeholders, our aim is to present a multi-perspective overview that offers a comprehensive understanding of the innovation barriers specific to the Dhc sector.

Table 4.1 categorizes the barriers into six clusters: personal, financial, cultural, behavioral, sectoral, and political. The table also specifies the sources of these studies and highlights the perspectives of the interviewees who identified these barriers. To supplement our findings, Appendix 1 includes relevant quotes from the interviewed stakeholders. Additionally, Appendix 1 provides a detailed description of each individual barrier listed in Table 4.1. This analysis allows us to partially fill in the sectoral building blocks and influencing factors of the TIS framework by linking the barrier categories to the seven TIS building blocks and seven influencing factors.

Table 4.1 Innovation barriers in the Dhc sector.

Category	No.	Barrier	Sources	Interviews
Individual	B1	Personal ability & succession (e.g. age, size, structure, experience)	(Caldera et al., 2019; Moons et al., 2022; Wreford et al., 2017)	Grower 4, Grower 5, Expert 2
	B2	Infrastructure and complementary inputs	(Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Wreford et al., 2017)	Expert 1
Economic	B3	Lack of financial benefits	(Caldera et al., 2019; Kishna et al., 2011; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017)	Grower 1, Grower 2, Grower 3, Expert 4
	B4	Lack of financial means, budget	(Caldera et al., 2019; Farhangi et al., 2020; Kuntosch et al., 2020; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017)	Grower 3, Grower 4, Entrepreneur 1, Entrepreneur 2 Expert 1, Expert 3
	B5	Cost of adoption	(Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017)	Grower 5, Grower 6, Entrepreneur 1
	B6	Effects on production or crops	(Caldera et al., 2019; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017)	Grower 2, Grower 3, Grower 4, Grower 5, Grower 6, Entrepreneur 1, Expert 1
Social & Cultural	B7	Cultural capital	(Moons et al., 2022; Wreford et al., 2017)	Grower 5, Grower 6, Entrepreneur 1, Expert 2
	B8	First mover fear	(Kishna et al., 2011; Moons et al., 2022)	Grower 2, Grower 5, Grower 6, Entrepreneur 1, Expert 3
	B9	Past experiences	(Moons et al., 2022)	Expert 4
	B10	Cross-sector communication and coordination| Culture difference		Grower 1, Grower 2, Entrepreneur 1, Expert 2, Expert 4
Behavioral & Cognitive	B11	Beliefs about climate change and sustainability	(Kuntosch et al., 2020; Moons et al., 2022; Wreford et al., 2017)	Grower 1, Grower 2
	B12	Perceived long time horizons	(Caldera et al., 2019; Farhangi et al., 2020; Wreford et al., 2017)	Grower 2, Grower 5, Grower 6, Entrepreneur 1

	B13	Time constrains	(Caldera et al., 2019;; Wreford et al., 2017)	Grower 3, Grower 4, Grower 5, Entrepreneur 1, Expert 1
	B14	Lack of knowledge or skills	(Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Kuntosch et al., 2020; Moons et al., 2022; Wreford et al., 2017)	Grower 3, Entrepreneur 1, Expert 2
	B15	Risk averse	(Caldera et al., 2019; Moons et al., 2022)	Grower 6, Entrepreneur 1, Expert 1, Expert 3, Expert 4
	B16	Competing pressures	(Farhangi et al., 2020; Kishna et al., 2011; Wreford et al., 2017)	Grower 2, Grower 5
Sectoral	B17	Lack of power in supply chain, Price takers	(Kishna et al., 2011; Melorose et al., 2015; Moons et al., 2022)	Grower 1, Grower 2, Grower 6, Expert 4
	B18	Customer behavior	(Kishna et al., 2011; Melorose et al., 2015; Moons et al., 2022)	Expert 4
	B19	Greenhouse size		Entrepreneur 1, Entrepreneur 2, Expert 3
Political	B20	Current climate policy	(Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Moons et al., 2022; Wreford et al., 2017)	Grower 1, Expert 4
	B21	Political uncertainty		Grower 1, Grower 3, Grower 5, Expert 4

4.2.1 SECTORAL INNOVATION BARRIERS AFFECTING THE TIS FRAMEWORK

This section aims to compare the identified innovation barriers in this study with the sectoral building blocks and influencing factors of the TIS framework (Figure 4.2). This will aid in the practical application of the TIS framework and associated STN model to the case study startups in later parts of the study. Furthermore, describing how innovation system barriers can affect the state of a TIS framework for a startup can help generalize the use of the TSI framework and STN model by showing what level of understanding is necessary to successfully apply both to any sector. For this, we compared the barriers from Table 4.1 to the TIS framework, see Figure 4.2.

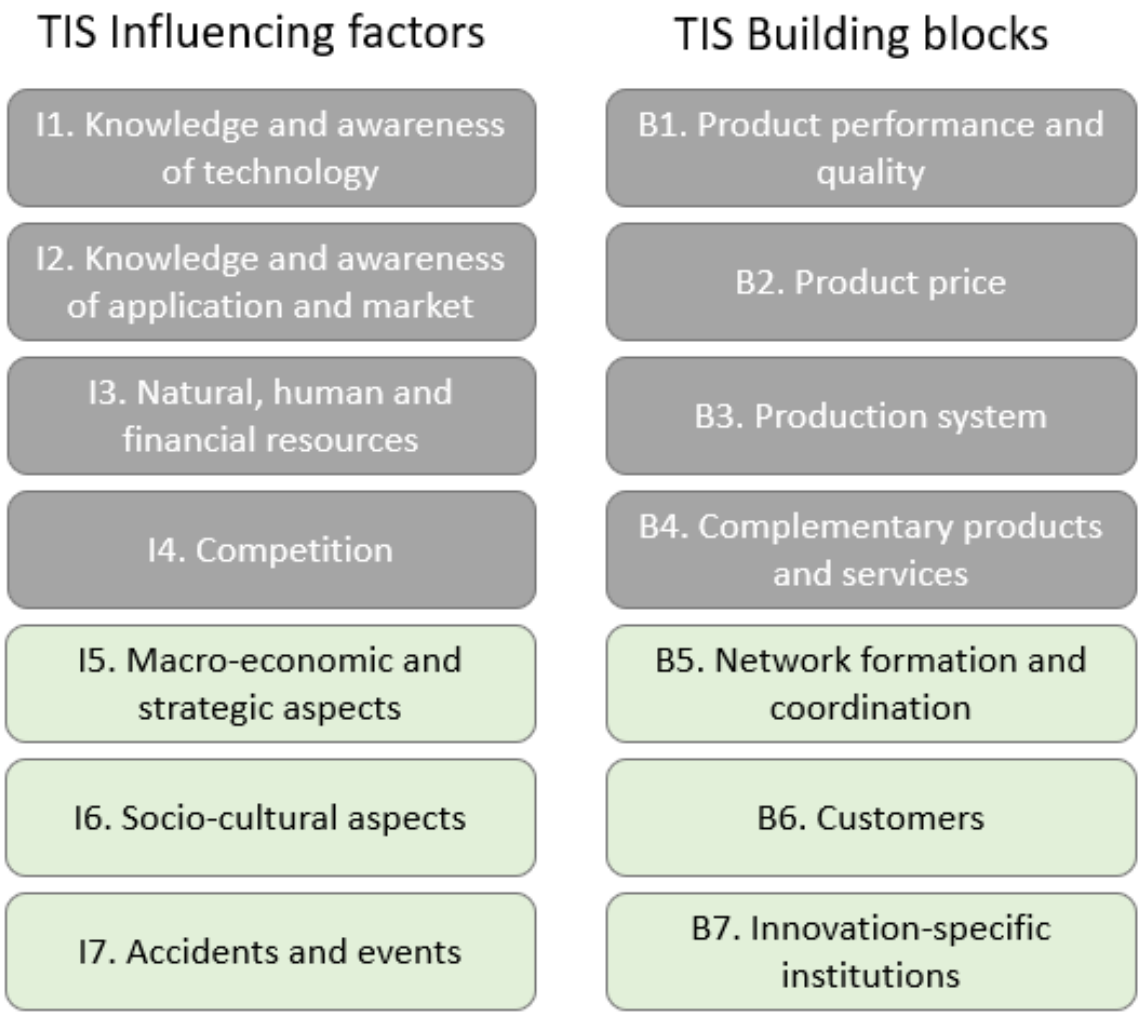

Figure 4.2 TIS framework with marked sectoral building blocks and influencing factors (adopted from Ortt & Kamp, 2022).

<u>B5. Network formation and coordination</u>

The first building block encompasses the network of actors of the sector and its coordination. For this building block, we will look at both the network of the startup and its technology as well as the sector the technology is in. Something which was already mentioned in the drivers of the sector, the network of stakeholder of the Dutch horticulture is highly specialized. The Netherlands can boast to have one of the, if not greatest, horticultural centers of the world. The Greenports are hubs of very close parties,

who all have personal connection with each other. Knowledge sharing in the Dhc sector, goes very quickly (Schout & Harkema, 2012). Many growers, knowledge institutions, growers associations and greenhouse builders all have close personal ties. This also means that once growers are happy with an innovation, many more growers will want to incorporate this new technology in their own greenhouse, while knowledge institutions explore ways to maximize its benefits.
These institutions, operating at regional and national levels, are dedicated to supporting the horticulture industry in its transition toward more sustainable production methods, as outlined in the stakeholder analysis in Appendix X. Notable participants in this network include Kas Als Energiebron, Priva, HortiTech, and HortiHeroes, among others, contributing to the development of sustainable practices.
Furthermore, it is important to consider the specific network associated with the startup, which will be elaborated upon in Chapter 6. Overall, the Dhc sector possesses a robust network that is likely to facilitate the efforts of sustainable startups. Consequently, the network-related TIS building block is not expected to impede the implementation of sustainable innovations for startups.

B6. Customers

From the startup perspective, growers will likely be the customers or the end-user to the sustainable innovations. In the list of barriers of Table 4.1, we can identify numerous barriers that hamper the growers from adopting new sustainable innovations. Barriers to the adoption of sustainable innovations by growers are grouped into several clusters, including individual characteristics such as age, tenure, experience, workforce size, and expertise. Financial, socio-cultural, and behavioral barriers also contribute to the challenges. One of the main concerns raised by growers in interviews is the potential impact of new innovations on their production or crops. Integrating new technologies into existing greenhouse systems requires time and knowledge, and any perceived risk to production can deter growers from adopting the innovation. In the interviews, Grower 5 mentioned how "*… just a couple LED lights change the temperature provide, growth, humidity etc.*" (Grower 5, Appendix 1). This uncertainty and the associated hidden transition costs form part of the financial barriers. Growers also exhibit a "first mover fear," hesitating to be the first to adopt untested technologies in their greenhouses due to intense industry competition and the risk of jeopardizing their harvest (Kishna et al., 2011; Moons et al., 2022). Risk aversion among growers further compounds this barrier. Startups aiming to overcome these barriers must provide clear evidence of the innovation's positive impact on production and crops while addressing growers' specific needs and concerns.
From this we can conclude that the customers can pose a significant barrier to the adoption and implementation of sustainable innovations.

B7. Innovation-specific institutions

Innovation-specific institutions encompass governmental policies, laws, and standard practices that can have both positive and negative effects on the adoption of sustainable innovations. The impact of legislation on specific innovations can vary on a case-by-case basis. However, here we will describe the broader effects of current legislation on sustainable innovations as a whole.

To support the horticulture industry in achieving their sustainable targets, the Dutch government has established political innovation institutions at both regional and national levels. These institutions, such as Kas Als Energiebron, Priva, HortiTech, HortiHeroes, and others, are dedicated to assisting the horticulture sector in innovating and transitioning to more sustainable production practices. Detailed information about these institutions can be found in the extensive stakeholder analysis in Appendix X. They play a crucial role in supporting the development of startups, technologies, and raising awareness in the Dhc sector. Furthermore, the government actively encourages sustainable innovations by providing subsidies and grants to growers who invest in such initiatives. This aligns with the sustainability goals of both Dutch and European institutions, as outlined in Appendix 4.
However, there are also hindering factors that affect the adoption of sustainable innovations within the sector. Table 4.1 highlights barriers stemming from political systems and climate policies. Existing literature indicates that certain policies can impede the adoption of sustainable innovations (Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Moons et al., 2022; Wreford et al., 2017). For example, regulations related to multifunctional buildings have created obstacles for the development of innovative food-producing initiatives like circular vertical farming (Farhangi et al., 2020). These barriers underscore the need for a supportive policy framework that encourages and facilitates the implementation of sustainable innovations in the horticulture sector.
Overall, the innovation-specific institutions can aid certain sustainable innovations, with some possibly hindering effects that target select innovations.

I5. Macro-economic and strategic aspects

The macro-economic landscape of the Dutch horticulture sector provides favorable conditions for sustainable innovation startups. Economic pressure on growers to increase production value and reduce emissions, coupled with the Dutch government's active promotion of sustainable innovations for the sector, creates a receptive market. However, there are barriers to widespread adoption.

Growers face limited power in the supply chain, with retail corporations driving down prices and hindering the ability to increase prices for sustainable or higher-quality products. Growers' associations are working to shift power dynamics, but change takes time (Kishna et al., 2011; Melorose et al., 2015). Consumer behavior also presents a barrier, as consumers still prioritize low prices over sustainability, which is now on an upward trend (Kishna et al., 2017; Melorose et al., 2015). Large greenhouse sizes pose challenges for startups, as testing innovations on a functional scale is costly (Expert 3, Entrepreneur 2). Overcoming these barriers requires strategies tailored to the sector, as demonstrated in the case study startups.

I6. Socio-cultural aspects

From the stakeholder analysis and the innovation barriers of the Dhc sector, a certain understanding of the socio-cultural dynamics of the Dhc sector could be gained. The sector has a strong cultural capital and identity associated with being a grower, which creates a sense of pride and status within the community. However, this cultural cohesion can be a double-edged sword. On the positive side, growers are open to innovation,

especially when it comes to improving crop quality and efficiency. When one grower adopts a new technology or practice, others are likely to follow suit. This social approval serves as a filter for innovation adoption, which contributes to the fact that there are no bankruptcies due to failed innovation (Expert 4, Appendix 1).
On the negative side, the close-knit nature of the sector can hinder the entry of new startups. Growers are often hesitant to change their traditional cultivation methods and may resist adopting non-field tested technologies. There is also a reluctance to embrace automation, as it can lead to a loss of ownership over their work tasks. Moreover, the overuse of the term "sustainability" has diminished its value in the industry, and growers prioritize their own production efficiency over sustainability considerations.
In terms of behavioral and cognitive barriers, growers may underestimate their greenhouse gas emissions and doubt the impact of their individual actions on climate change. The perceived long time horizon for innovation adoption, government policy uncertainties, time constraints for implementing changes, lack of knowledge and skill in integrating new technologies, and risk aversion among growers further impede the adoption of sustainable practices. Additionally, growers face competing pressures, including financial and political stress, which make them cautious about investing in new products or innovations.

I7. Accidents and events
The ongoing war in Ukraine is a significant event that impacts the diffusion of innovations in the sector. While tragic, the war has caused a sharp increase in energy and gas prices, prompting growers to seek energy-reducing technologies. The need to reduce energy consumption and lower costs has become more pressing. Consequently, the war has created favorable conditions for the adoption and spread of energy-efficient technologies among growers, enhancing the potential for the diffusion of innovations.

4.2.2 MOST REFERED INNOVATIN BARRIERS OF THE DHC SECTOR

In this section, we describe what barriers are more top-of-mind for stakeholders than others. This contributes to understanding of the Dhc innovation system that affect the TIS framework. Understanding what barriers are more top-of-mind to certain stakeholder groups gives insight into why particularly, the Customers (B6) hamper the adoption of sustainable innovation through the socio-cultural aspects. To do this, we constructed Table 4.2 where the number of time each barrier was referenced by a certain stakeholder group.

The most commonly mentioned barrier by growers is the effect on their production or crops any new innovation can have. New innovations change the dynamics of existing greenhouse systems. Optimizing those with new innovation takes time and expertise. This explains why growers are hesitant to adopt new innovations in their greenhouses and provides insight into means to overcome this particular barrier. Meanwhile, entrepreneurs most frequently mentioned the lack of financial means and greenhouse size as obstacles. This demonstrates the difficulty startups face in producing prototypes on a large enough scale to test in large greenhouses and gain necessary data. Getting the

financial means to test and increase product performance is a big hinderance for startups. This forms a negative cycle with the growers who do not which to negatively affect their own production by testing new innovation in their greenhouses. This also explains why experts state that growers risk-averse stance to innovation adoption is a barrier.

Determining the cause of the most hindering innovation barrier for startups will help those startups formulate appropriate niche strategies to overcome the barrier using the STN model.

Table 4.2 Barriers referenced in interviews with stakeholders

		Amount referenced by			
Barrier Type	Barrier name	Growers	Entrepreneurs	Experts	Total
Individual	-				4
	Personal ability	2	0	1	3
	Infrastructure and complementary inputs	0	0	1	1
Economic	-				20
	Lack of financial benefits	3	0	1	4
	Lack of financial means, budget	2	2	2	6
	Cost of adoption	2	1	0	3
	Effects on production or crop	5	1	1	7
Social & Cultural					15
	Cultural Capital	2	1	1	4
	First mover fear	3	1	1	5
	Past experiences	0	0	1	1
	Culture difference	2	1	2	5
Behavioral & Cognitive					21
	Beliefs about sustainability	2	0	0	2
	Perceived long time horizons	3	1	0	4
	Time constrains	3	1	1	5
	Lack of knowledge and skill	1	1	1	3
	Risk averse	1	1	3	5
	Competing pressures	2	0	0	2
Sectoral					8
	Lack of power supply chain	3	0	1	4
	Customer behavior	0	0	1	1
	Greenhouse size	0	2	1	3
Political					6
	Current climate policies	1	0	1	2
	Political uncertainty	3	0	1	4

5. STN MODEL

This chapter describes the STN (SBMC, TIS, Niche) model developed in this study and how it can be used as a tool for sustainable startups looking to create and implement niche strategies (Figure 5.1). The STN model provides startups with a tool to apply the TIS framework, find and implement niche strategies, and further development of their business models. The STN model is based on the connection of the SBMC, TIS framework, and Niche strategies, and its name reflects this. The individual parts of the STN model have been explored in detail in Chapter 3, so we will not repeat them here. Here, we will provide a brief description of the steps of the model and their usage. A detailed step-by-step description and application of the model is provided in Appendix 3, and a link to the online model is available in Appendix 5.

The first step of the STN model is to fill in the SBMC (Figure 5.1). Filling in the SBMC will help structure the business model of the startup. The next step of the model is to apply the TIS framework as described by Ortt & Kamp (2022) (Step 2, see Figure 5.2). This will be done by asses the status of the seven building blocks first, followed by the status of the seven influencing factors. The assessment of the TIS framework will highlight what building blocks form barriers hampering the implementation of the sustainable innovation of the startup. Here, the first novelty of the STN model can be found. This study has formed connections between the seven TIS building blocks and the eleven parts of the SBMC.

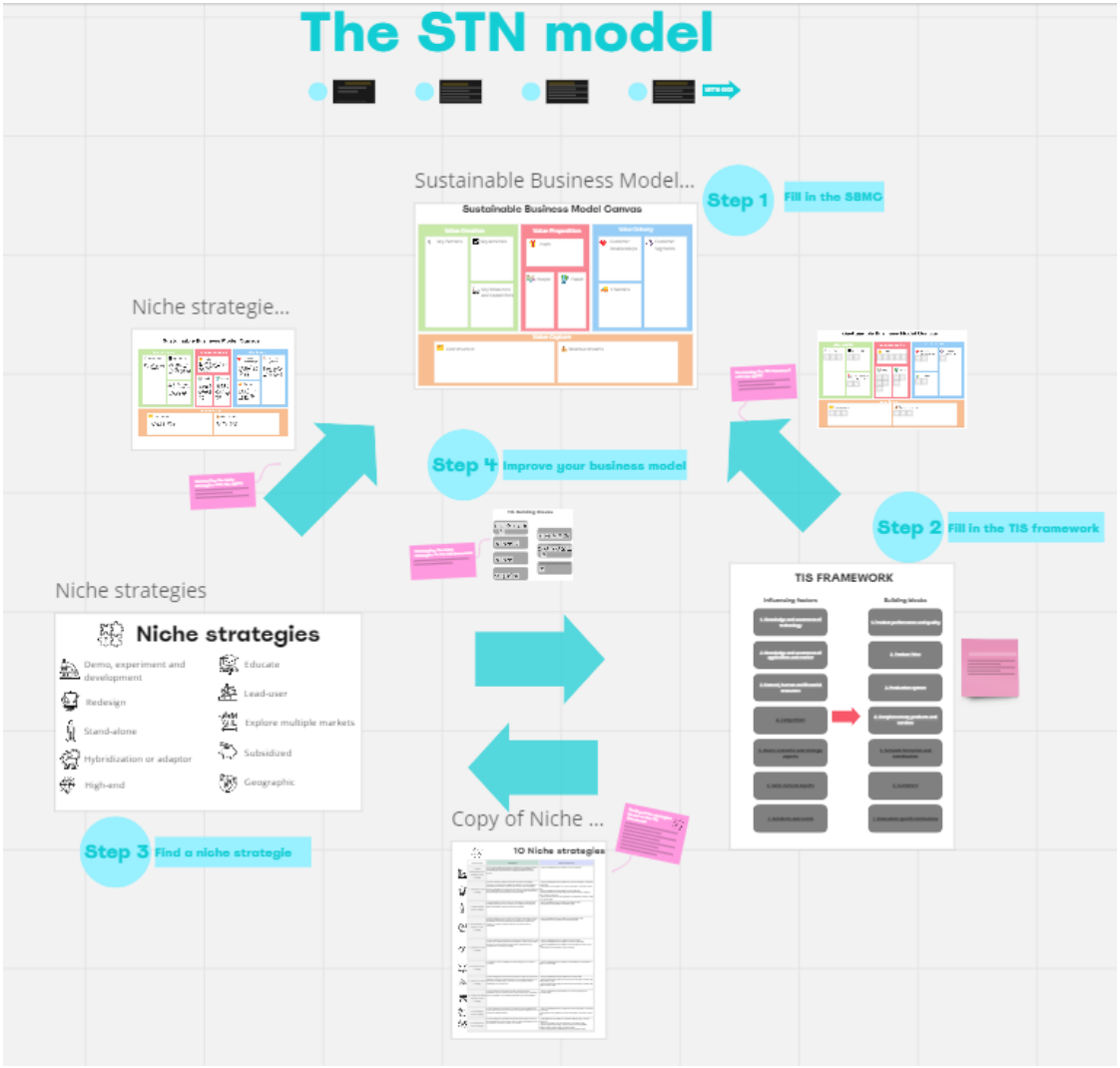

Figure 5.1 Overview of the STN model.

In this figure, the over view of the STN model is depicted in Miro. The model is an online tool for filling in the SBMC (Step1), applying the TIS framework (Step 2) and finding appropriate niche strategies (Step 3). The model also shows how the SBMC, TIS framework and niche strategies are interconnected (Step4). This connection can help startups understand the use and implications of implementing niche strategies to improve their business models.

5.1 CONNECTING THE TIS BUILDING BLOCKS TO THE SBMC

In this section, we will explore the connections between the seven TIS building blocks and the 11 parts of the SBMC, as presented in Table 5.1. Figure 5.2 depicts how each part of the SBMC is connected to one or more TIS building blocks. In Appendix 3, a detailed description is given of how each individual TIS building block is linked to the SBMC parts.

This connection allows business leaders to assess the readiness of their business models. From the application of the TSI framework, building blocks have been asses which pose implementation barriers to the innovation. By connecting the TIS building blocks to the SBMC parts, similar assessments can be made of the SBMC parts. It is important to note that not all the SBMC parts that an “incomplete” TIS building block is connected to, are similarly incomplete. The connection is mean to help highlight what parts of the SBMC

might be incomplete. It can aid startups in assessing their business models and finding targets for the niche strategies, that can be formed in the next step (Step 3).

Table 5.1 Connection between TIS building blocks and SBMC blocks

TIS building block	SBMC block
B1. Product Performance and Quality	Key Resources and Capabilities (Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet
B2. Product Price	Key Partners Key Resources and Capabilities (Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet Cost structure Revenue streams
B3. Production System	Key Partners Key Activities Key Resources and Capabilities (Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet Channels
B4. Complementary products and services	Key Partners Key Activities (Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet Channels
B5. Network formation and coordination	Key Partners (Value Proposition) People Customer Relations Channels Cost structure Revenue streams
B6. Customers	(Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet Customer Relations Customer Segments Cost structure Revenue streams
B7. Innovation-specific institutions	Key Partners (Value Proposition) People

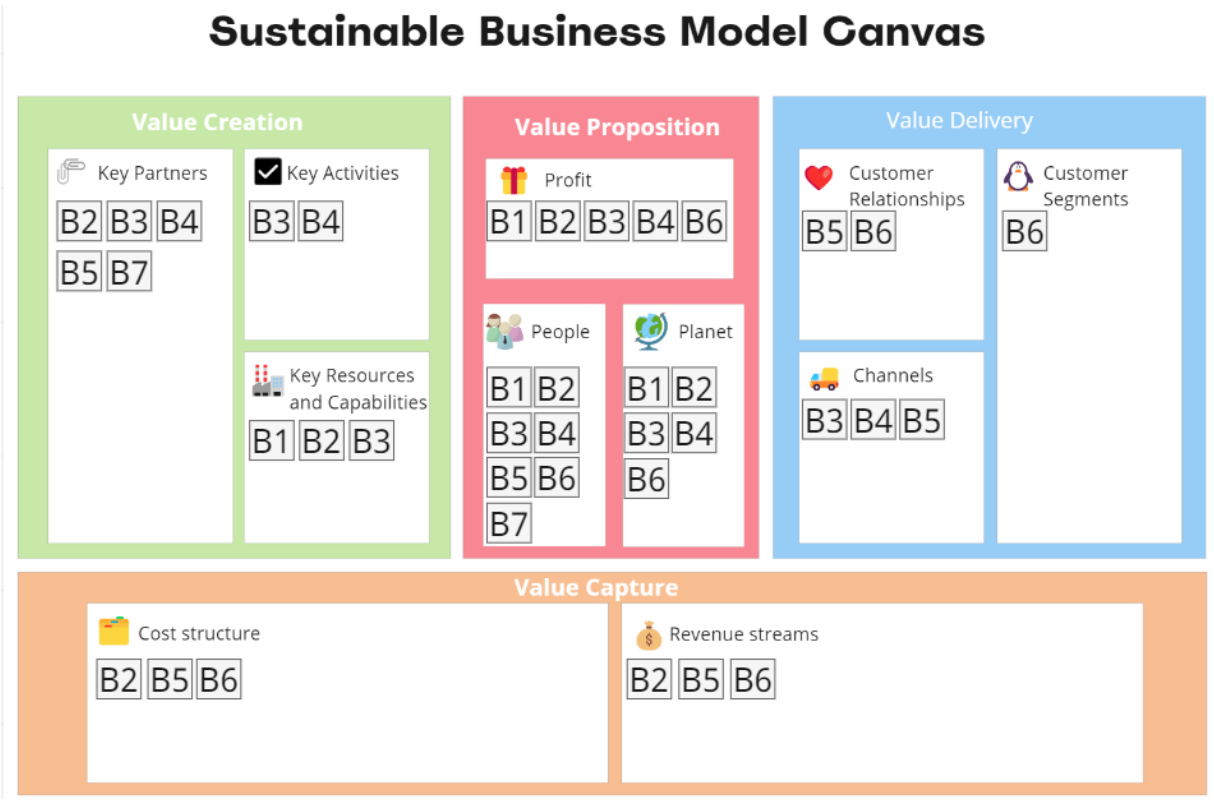

Figure 5.2 TIS building blocks connection to SBMC.
In this figure, the TIS building blocks, B1 to B7, are depicted in the SBMC parts they have a connection to, based on Table 5.1.

The third step in the STN model is to identify a suitable niche strategy for the startup. This can be achieved by referring to the Table 3.1 of Chapter 3, which provides niche strategies based on the current status of the TIS framework. Once a niche strategy is determined, the connection of the niche strategies to the TIS framework and SBMC can be made.

5.2 CONNECTING NICHE STRATEGIES TO TIS AND SBMC

In this section, we will examine how niche strategies can impact the TIS building blocks and SBMC. Understanding how certain niche strategies can affect the business through the TIS framework and SBMC can help choose particular targets for the niche strategies. For this purpose Table 5.2 was created, which connects niche strategies to specific TIS building blocks and SBMC parts likely to be affected by them. Appendix 3 provides a detailed description of how each niche strategy can affect the respective TIS building blocks and SBMC parts.

It is important to note that there are various ways to implement each niche strategy, and startups should customize their approach to address their specific needs. The effects we describe below are based on the potential impact that niche strategies can have on the TIS building blocks and SBMC, as outlined in Table 5.2. Ultimately, startup leaders must determine how to leverage these strategies to enhance their TIS building blocks or SBMC components continuously.

Table 5.2 Description of the effects of niche strategies on the TIS building blocks and SBMC

Generic niche strategies	**Description of the niche strategy**	**Effect on TIS building blocks**	**Effect on SBMC**
1 Demo, experiment and develop niche strategy 	For this niche strategy the product is showcased to a specific audience in a controlled setting, minimizing performance or quality limitations. Experimenting is a vital part of this strategy to develop the product further.	B1. Product Performance and Quality B5. Network formation and coordination B6. Customers	Key Partners Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships Customer Segments Channels
2 Redesign niche strategy 	A product redesign strategy can improve market fit by simplifying production or adapting it to a different application. A niche strategy can be adopted to introduce a simpler version of the product, leveraging existing knowledge and resources to reduce costs. The niche strategy can also involve exploring an application with more favorable institutional or market conditions that may require product redesign.	B1. Product Performance and Quality B2. Product Price B3. Production System B4. Complementary products and services B5. Network formation and coordination B6. Customers B7. Innovation – specific institutions	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Segments Channels Cost Structure Revenue streams
3. Stand-alone niche strategy 	A niche strategy to use the product as a standalone or integrated with B4. Complementary products and services . The strategy can for example adopt a local network where infrastructure is limited.	B1. Product Performance and Quality B5. Network formation and coordination	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships Customer Segments Channels
4. Hybridization or adaptor niche strategy 	A niche strategy to use the product in combination with existing products, leveraging B4. Complementary products and services . This strategy can for example be used to reuse all existing B4. Complementary products and services , or provide an adapter/convertor to make the product compatible.	B1. Product Performance and Quality B2. Product Price B3. Production System B4. Complementary products and services B5. Network	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Segments Channels Cost Structure Revenue streams

		formation and coordination B6. Customers B7. Innovation – specific institutions	
5. High-end niche strategy 	A niche strategy can be adopted to produce hand-made products in small numbers for a specific high-end market segment. Products can be made to order for the top niche of B6. Customers with a special product, to maximize returns (skimming strategy).	B1. Product Performance and Quality B2. Product Price B3. Production System B6. Customers	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships Customer Segments Channels Cost Structure Revenue streams
6. Educate niche strategy 	A strategy to transfer knowledge of the technology to the suppliers or B6. Customers.	B5. Network formation and coordination B6. Customers	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships Channels
7. Lead user niche strategy 	A niche strategy can be used to find innovators or lead users who can co-develop a product and experiment with it. This strategy enables firms to learn about suitable designs, as expert users are highly involved in developing the product further.	B1. Product Performance and Quality B5. Network formation and coordination B6. Customers	Key Partners Key Activities Key Resources and Capabilities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships
8. Explore multiple markets niche strategy 	A niche strategy can be adopted to explore multiple customer applications and find successful ones through trial and error. Visibility of the first applications can stimulate explorative use in new applications.	B5. Network formation and coordination B6. Customers	Key Partners Key Activities Value Proposition – Profit Value Proposition – People Value Proposition – Planet Customer Relationships Customer Segments Channels Cost Structure
9. Subsidized niche	A niche strategy can be adopted to subsidize the product development using public funds if the use of product by a particular segment of	B2. Product Price B6. Customers	Value Proposition – Profit Value Proposition – People Value Proposition –Planet Cost Structure Revenue streams

strategy 	users is considered societally relevant.		
10. Geographic niche strategy 	A niche strategy can be adopted to move the product launch to a more favorable geographic area based on local or regional characteristics such as institutions, resources, suppliers, or B6. Customers.	B4. Complementary products and services B5. Network formation and coordination B6. Customers B7. Innovation-specific institutions	Key Partners Channels Customer Segments Cost Structure

By connecting the niche strategies to the TIS building blocks, the startup can gain deeper insight into how their chosen niche strategies can improve the TIS building blocks. This provides more clarity and a clear target for the niche strategies.

Likewise, by connecting the niche strategies to the SBMC, the startup can improve the parts of the SBMC that are lacking. The lacking parts of the SBMC are found through the connection with the TIS building blocks as previously described. The connection of the SBMC to TIS building blocks and niche strategies creates clear targets for the startup to focus on to improve, as well as means to improve them through niche strategies.

6. APPLICATION OF THE STN MODEL

In this chapter, we will describe application of the STN model to two case study startups. The goal of this approach is to gain insight into the practical use of the model and determine how it could be improved. In addition, the application to current startups will provide examples of the application of the STN model.

6.1 TIS APPLICATION TO CASE STUDY STARTUPS

In this section, will be described how the TIS framework was applied to both startups. Additionally, we will describe the results from the application and what we have learned from this application. The TIS framework was implemented in a workshop with sustainable startups, where the status of the building blocks and influencing factors was evaluated with the guidance of the researcher. For the workshop, a summary of the framework was provided to the participants in Appendix 5. In addition, the researcher gave insights into each building block and influencing factor to ensure thorough consideration. For instance, the cost of adoption and installation was included in the assessment of Product Price.

In the application of the TIS framework in this study, there was no clear assessment criteria to differentiate between the three statuses of the TIS units; not compatible, partly compatible, and fully compatible. During the workshop, the participants utilized varying means of assessment. Thermeleon reassessed the framework based on a relative scale, comparing the biggest hindering block or factor, with the least. The least hindering building block was compatible, anything similar was also compatible, while anything similar to the most hindering block was not compatible. For anything uncertain, partly compatible was used.
FOTONIQ also assessed the framework in a relative manner, but through a slide Likert scale. The best building blocks, were on the far left (number 1) was not hindering or positive, while the far right (number 5) was most hindering. All point in between were marked on the slide scale based on their relative state.

These varying assessment methods were purposefully left to the participants as those were based on their own preferable means of communication within the teams. What is noteworthy however, is that both took freedom of the assessment criteria to isolate the most hindering building block and influencing factors. The flexibility of assessment criteria of the TIS framework it provides startups with the flexibility to apply it based on their individual interpretation and needs.

6.1.1 COMPARING THE TIS FRAMEWORKS

Figures 6.1 and 6.2 show the TIS frameworks for Thermeleon and FOTONIQ respectively. The application of the TIS framework to the two sustainable startups revealed similarities in their failing TIS building blocks, albeit to varying degrees. This could indicate that these barriers can also hamper the innovation of other sustainable startups in the Dhc sector.

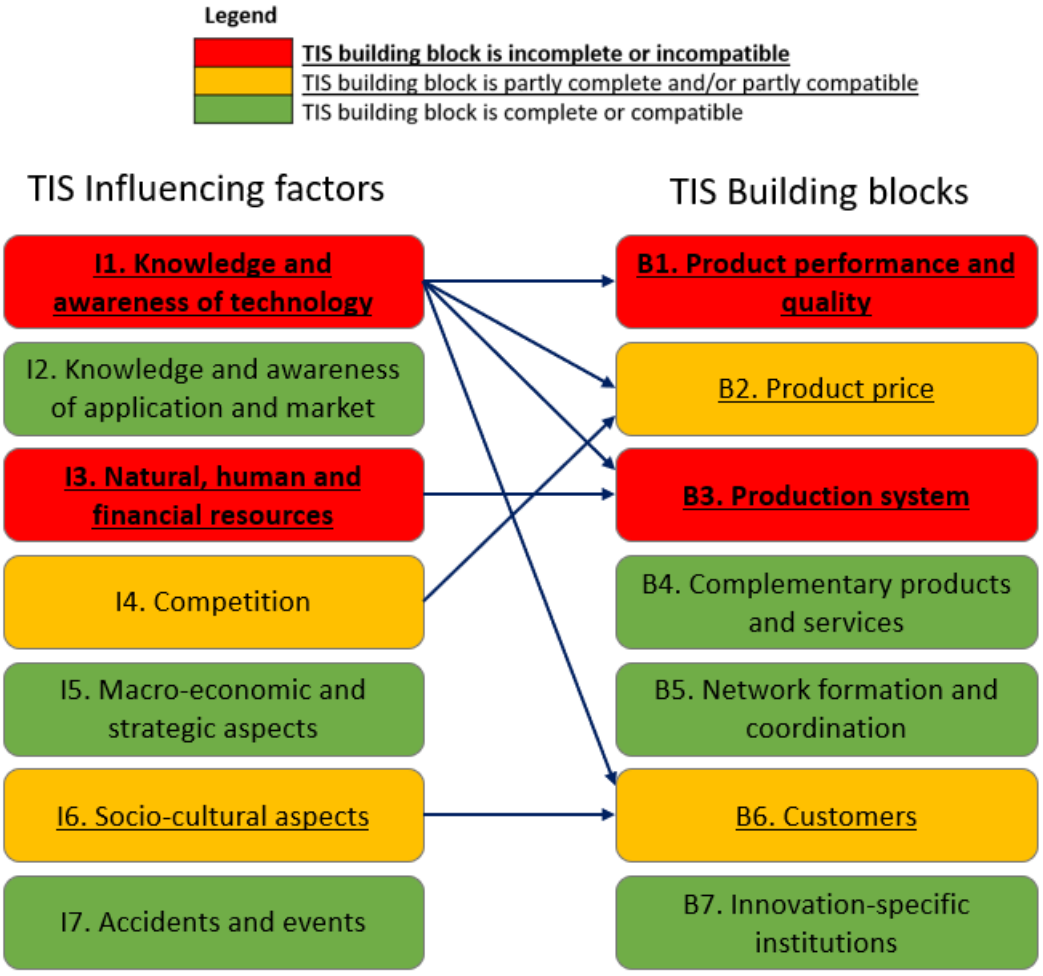

Figure 6.1 TIS framework applied for the Thermeleon HeatBattery

This figure depicts the status of the seven TIS building blocks and seven influencing factors. The legend above provides an overview of the three states and their associated formats and colors. The arrows in the figure indicate the influencing factors that affect the building blocks.

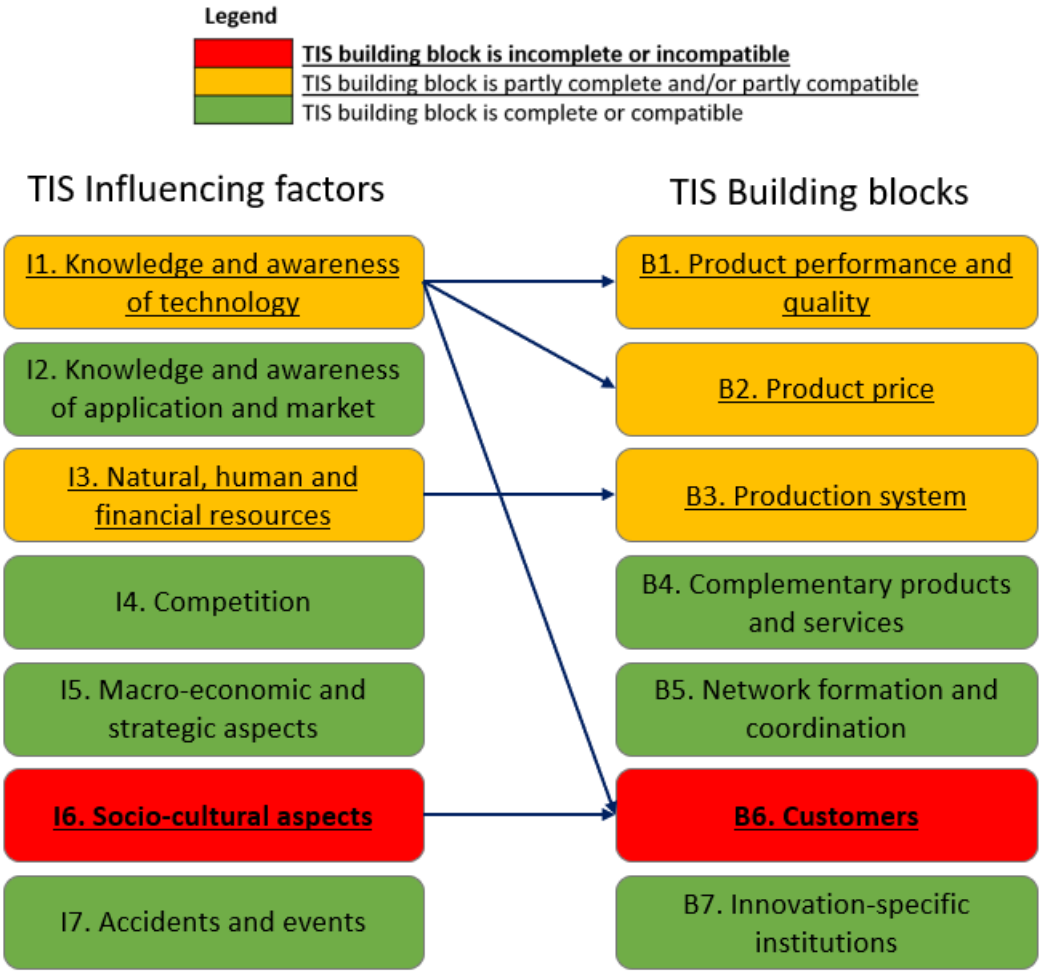

Figure 6.2 TIS framework applied for the PAR+ coating by FOTONIQ.
This figure depicts the status of the seven TIS building blocks and seven influencing factors. The legend above provides an overview of the three states and their associated formats and colors. The arrows in the figure indicate the influencing factors that affect the building blocks.

Both startups mentioned facing difficulties in testing their innovations for large greenhouses and integrating them into existing technological systems of the greenhouses. As a result, obtaining real world data regarding the functionality of their innovations hampers the startups in testing the performance of their products and improving the quality resulting in lack of building block B1 (Product Performance and Quality).
In regards to the Product Price (B2) depends on both financial and non-financial cost of procurement are important. Both startups mention that the non-financial cost of procurement, namely the integration of their products with the current greenhouse systems, is a big problem for them. Greenhouse technologies are complex, with many factors affecting numerous important environmental variables which need to be managed. These cost of adoption are also shown in Table 4.1 (Chapter 4), and form a key sustainable innovation barrier typical to the Dhc sector.

Both B1 and B2 are affected by the lack of knowledge due to a lack of testing opportunities of their innovation in the greenhouses. This speaks to sector related barriers of the growers to the willingness to test new innovations.

Another commonality found in the study was the lack of a robust Production System (B3). This can be attributed to the case study selection of the startups. Startups were selected which have had their first client contact and did not have large-scale product integration or a label of 'scale-up.' As a result, building block B3 (Production System) was lacking in both startups.

Complementary products and services (B4) was similarly, for both startups fully compatible with large scale diffusion of their respective innovations. Thermeleon mentioned how installation of their innovation can be done by other companies already operating in the Greenports they wish to enter as well as measurement tools operating in several greenhouses that can provide the startup with the data needed to assess the success of their innovation once fully installed in the greenhouses. Similarly, FOTONIQ can also utilize current chalk coating companies for the application and removal of their specialized PAR+ coating.

The sector related building blocks display similar assessment as described in Subchapter 5.2. The Network formation and coordination (B5) of the startup with the sector is well established for both startups as they made use of the dynamic and strong ties stakeholders of the Dhc share. The growers, as end-users, form a barrier to diffusion to both startup innovations. From the interviews performed by this study was concluded how the growers of the sector have a risk-averse and conservative stance forward adoption of sustainable innovations. While this is a generalized statement and does not apply to all growers, overall, it highlights the importance of understanding the Customer Segments and targeting the right grower segments with a specified niche strategy.
Finally, both startups share no negative effects of innovation-specific institutions to their innovations.

The disparity between the two figures can be attributed to differences in the companies and their respective assessment scales. Thermeleon is currently prioritizing the acquisition of financial resources for their production process and conducting large-scale prototype testing. On the other hand, FOTONIQ is confident in both their available resources and the quality of their prototype and production, with their main focus solely on sales. Additionally, Thermeleon is highly aware of their competitors and the comparative value of competing technologies. They are actively considering the strengths and weaknesses of other technologies in the market. In contrast, FOTONIQ is confident that their coating possesses higher quality than that of their competitors. Consequently, their visions regarding customers and associated socio-cultural aspects differ due to the current challenges they face as startups. Thermeleon's primary focus lies in product improvement and scaling up testing processes, while FOTONIQ is concentrated on sales and expansion. As a result, hesitant and risk-averse customers present a greater obstacle to FOTONIQ than they currently do to Thermeleon.

6.1.2 SBMC VALIDATION USING THE TIS FRAMEWORK

Through the connection of the TIS building blocks with the SBMC, the assessed TIS framework could be used to validate the SBMC of the case study startups. For each of building block, partly or not compatible (Orange or **Red**, respectively), the connected SBMC parts were validated. Since the same building blocks were not (completely) compatible with large scale diffusion for both startups, a similar connection was observed.

The four incomplete TIS building blocks of both startups are, B1) the Product Performance and Quality, B2) the Product Price, B3) Production System and B6) the Customers.

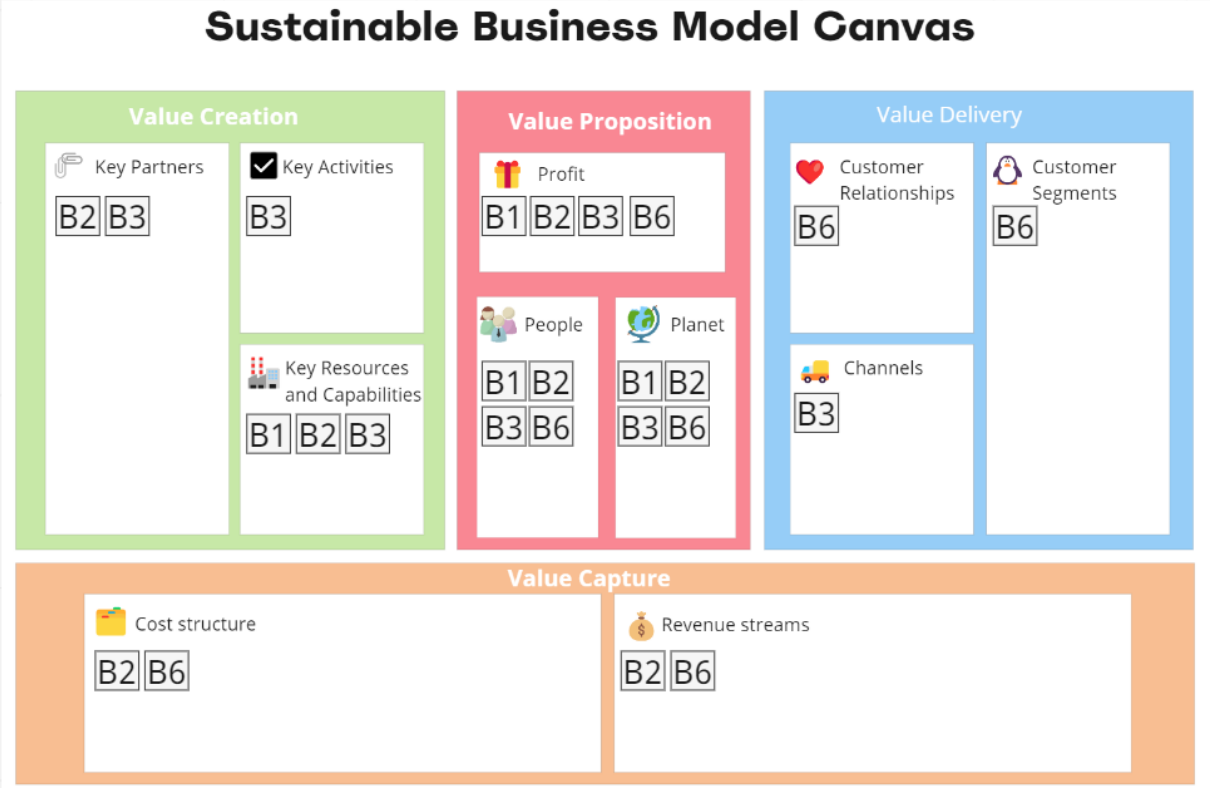

Figure 6.3 Incomplete TIS building blocks affecting SBMC

The boxes in the figure depict the 4 building blocks (B1, B2, B3 and B6) which are incomplete for Thermeleon and FOTONIQ. The locations of the boxes indicate how the various incomplete building blocks are connected to the SBMC.

Through this connection, the failing parts of the SBCM could be identified and described. This helped set clear targets for the niche strategies which are chosen in the next step of the STN model.

6.2 NICHE STRATEGY FORMATION AND IMPLEMENTATION

The next step of the STN model is to formation and implementation of niche strategies from the TIS framework. This section outlines how the niche strategies were identified and tailored to suit the specific circumstances of the case study startups. Additionally, the implementation process is discussed, including the use of a timeline to guide the execution of the strategies.

6.2.1 NICHE STRATEGY FORMATION

The selection of niche strategies was based on Table 3.1, utilizing criteria adapted from Ortt et al., (2013). However, in order to personalize the strategies, this study aimed to formulate strategies that were specific to each startup and their current situation. Initially, a careful evaluation was conducted to identify the most hindering TIS building blocks and influential factors within the TIS framework. The niche strategies were then chosen to address and overcome these barriers. For each startup, the strategy formulation process involved providing an explanation of how to adopt the selected strategy in a manner that targets the specific SBMC parts that may be lacking. Furthermore, secondary strategies were assigned to address additional TIS building blocks and SBMC parts that needed improvement. This combined strategy approach was inspired by the case study startup Thermeleon, which was already pursuing a Lead-user niche and had committed to a Demo and Development niche at the time strategic advice was given. The main advantage of combining niche strategies is the ability to efficiently target failing SBMC parts or lacking TIS building blocks, resulting in a more personalized impact for each startup. However, it is important for startups to recognize that this approach may require increased focus and planning compared to a singular niche strategy.

6.2.2 NICHE STRATEGY IMPLEMENTATION

Once the niche strategies were selected for the sustainable startups, a timeline was created to facilitate their implementation and prepare the startups for potential outcomes. The timeline includes two possible scenarios: the positive case and the negative case. By considering both scenarios, startups can anticipate and respond effectively to the actual results of the niche strategies. While it is impossible to predict the exact outcome of a strategy, preparing for both positive and negative cases enables startups to be more agile in their response.

For example, Thermeleon's case demonstrates that the Demo and Development niche strategy can have extreme outcomes, the prototype either works perfectly or not at all on a larger scale (Figure 6.4). The possible effect of these outcomes on the state of the startups TIS framework has been described to determine what strategy could be used following these results. By developing a plan for both of these outcomes, startups can respond quickly and effectively to any actual outcome that falls between these extremes. By preparing for the most extreme outcomes, startups can become better equipped to respond to any actual outcome, reducing their risk and increasing their chances of success in the market.

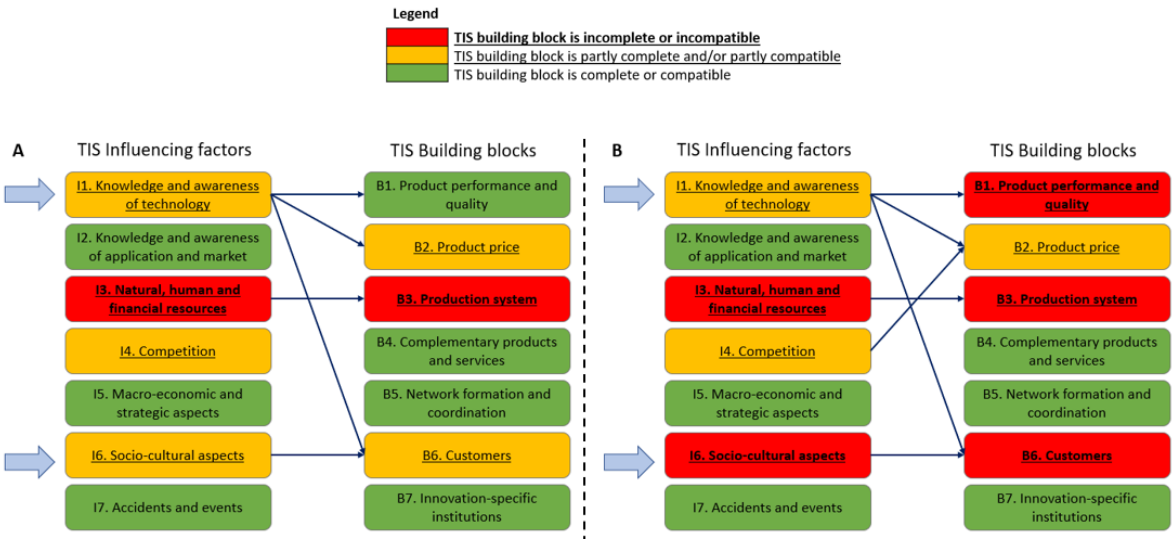

Figure 6.4 Status of the TIS framework Thermeleon in the positive case (A) and negative case (B).
This figure depicts the status of the seven TIS building blocks and seven influencing factors for Thermeleon, in case the first niche strategy outcome is positive (A on the left side) and negative (B on the right side). The legend above provides an overview of the three states and their associated formats and colors. The small arrows in the figure indicate the influencing factors that affect the building blocks. The large blue arrows in the figure specify the targets of the implemented niche strategy.

The timeline provides startups with a clear and structured plan for implementing their niche strategies, allowing them to monitor progress and adjust strategies accordingly (Figure 6.5). This approach can benefit future sustainable startups by providing them with a tool for risk management and preparation for potential outcomes. By using the timeline, startups can increase their chances of success in the market, as they are better equipped to respond to any actual outcome.

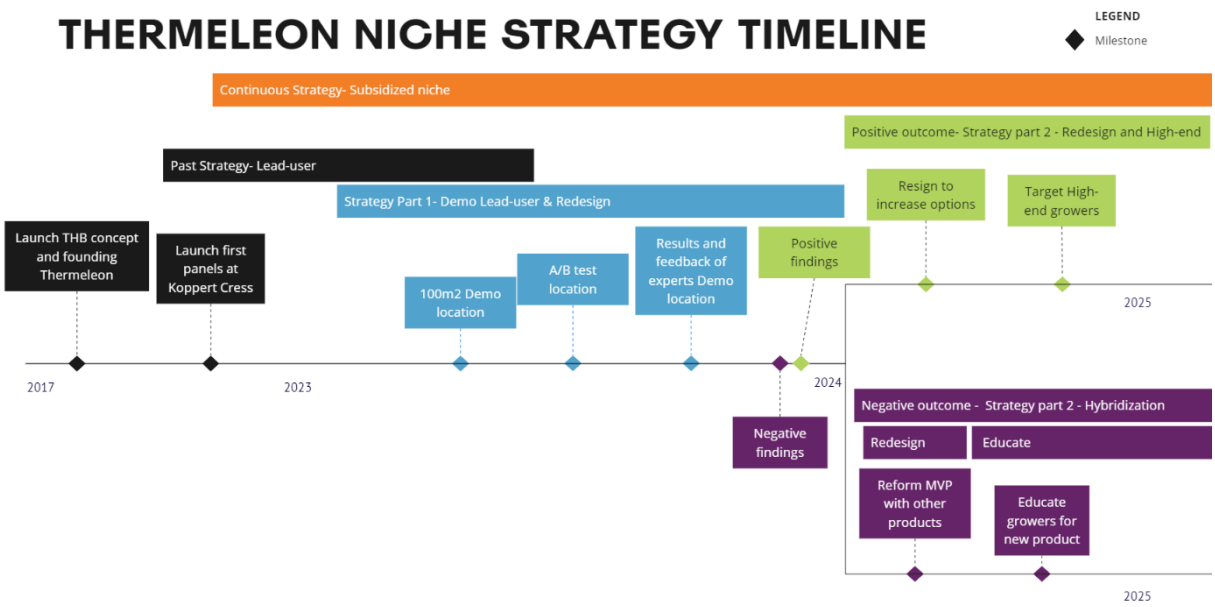

Figure 6.5 Timeline for niche strategy implementation

This figure depicts a timeline of niche strategies for Thermeleon over time. The black strategies represent the previous approaches used by the company, while the blue strategies describe the initial strategies recommended in this study. The milestone boxes indicate the potential steps involved in implementing each strategy. The green boxes represent the niche strategies in the positive case of the initial strategy (Positive case). The purple milestones describe the niche strategies in the negative case. The orange boxes highlight the niche strategies that can be used continuously by Thermeleon.

6.3 NICHE STRATEGY EFFECTS ON BUSINESS MODELS

Finally, the potential impacts of the formulated niche strategies were outlined, taking into account their connection to the SBMC and TIS framework, as discussed in Subchapter 5.2. This analysis aimed to evaluate whether the chosen niche strategies effectively enhance the TIS building blocks that were initially identified as the primary obstacles.

For each niche strategy was described how it effects the TIS building blocks and SBMC parts (Figure 6.7). This was done with special focus on the building blocks and SBMC parts which were lacking or hindering the startup. Describing and theorizing the potential effects of the selected niche strategies serves as a crucial evaluation tool. It allows for an assessment of whether the strategies truly contribute to improving the identified TIS building blocks. Furthermore, it provides a roadmap or set of requirements for implementing the strategies in a manner that optimizes their impact on as many TIS building blocks and SBMC components as necessary for the startup's success.

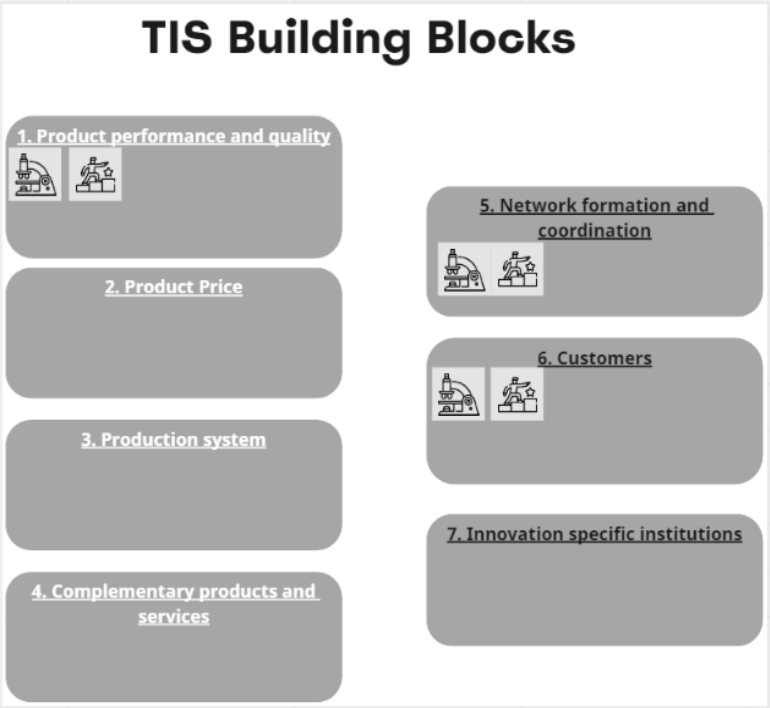

Figure 6.6 Effects of niche strategies on the TIS building blocks

The icons in this figure depict the Demo and development niche strategy (microscope) and Lead-user niche strategy (person on stairs). The location of these icons indicate what TIS building blocks the niche strategies can affect.

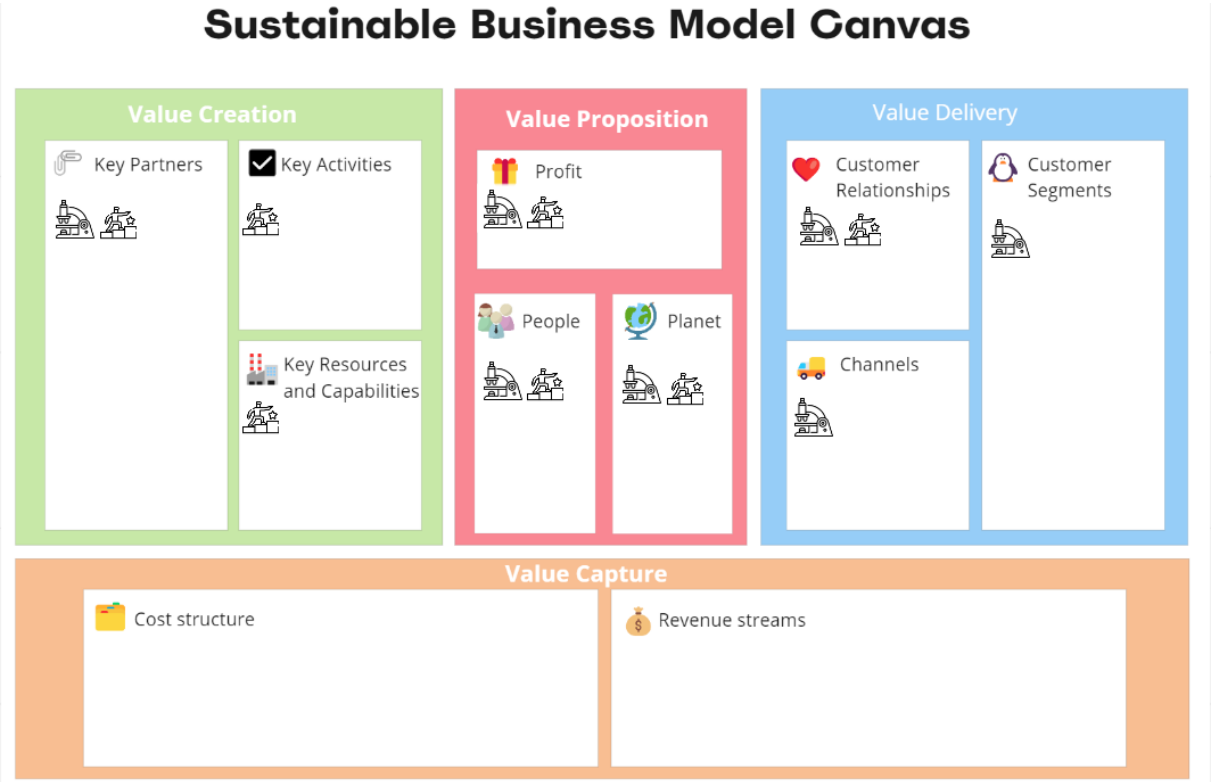

Figure 6.7 Effects of niche strategies on the SBMC

The icons in this figure depict the Demo and development niche strategy (microscope) and Lead-user niche strategy (person on stairs). The location of these icons indicate what parts of the SBMC the niche strategies can affect.

7. VALIDATION OF THE STN MODEL

In this chapter, the application of the STN model will be validated through feedback obtained from the case study startups and lessons learned from its practical implementation. The chapter aims to discuss the learnings from the application process and propose improvements to the model. Additionally, the chapter explores the potential of the STN model for a broader application in other sectors.

7.1 FEEDBACK STARTUPS

Both case study startups were asked to provide feedback on the utility of the STN model and the documents provided by this study (Appendix 5). The feedback received from the startups offered valuable insights into the effectiveness of the model and highlighted areas for improvement.

Thermeleon described how helpful the TIS framework was in assessing the viability of technology and choosing a suitable niche strategy to improve its viability. This suggests that incorporating the TIS framework into the SBMC can help startups identify areas that need improvement and select appropriate niche strategies to address those areas. Furthermore, using the TIS framework to formulate niche strategies for each startup phase can help visualize the underlying reasons for the chosen niche strategy. This makes it easier for startups to clearly communicate their strategy, including how each niche strategy follows one another. This emphasizes the importance of visual expression in the STN model as a tool for communicating niche strategies.

Another important finding from the feedback was that FOTONIQ recommended regularly revisiting the assumptions made during the niche strategy formulation process (Appendix 2). This is because some assumptions may no longer hold true, while new ones may have emerged. This highlights the need for startups to regularly evaluate their niche strategies and make necessary adjustments to ensure their relevance and effectiveness. This also further highlights the utility of the STN model as an online tool to facilitate the repeated evaluation and (re-)adjusting of niche strategies.

In summary, the practical application of the STN model reveals several important observations. The flexibility of the assessment criteria within the TIS framework allows startups to adapt and utilize the framework across multiple stages of their startup journey, enhancing the utility of the online STN model. Identifying the main hindering building block and influential factors within the TIS framework is crucial for accurately assessing areas that require improvement and formulating relevant niche strategies. The selection of multiple niche strategies in specific situations enables startups to enhance their business development more efficiently. These strategies can be organized into a timeline, creating an implementation plan that can be continuously revisited and re-evaluated over time.

7.2 LEARNINGS FROM THE APPLICATION

During the application of the model, several important learnings were observed, which are worth noting and can contribute to further improvements.

TIS Framework

1. Assessment Criteria Variations: The application of the TIS framework revealed that startups had varying assessment criteria and methods. This flexibility allows startups to adapt the framework to their specific needs and reuse it for different stages of their startup process. However, it is crucial to establish the main hindering building blocks and influencing factors. This clarity is necessary not only for determining the scale of assessment but also for identifying areas that require improvement and finding niche strategies for subsequent steps.
2. Understanding the Innovation System: A deep understanding of the innovation system in the Dhc sector was found to be essential for properly assessing the TIS framework for startups. This understanding includes knowledge about networks, cultural norms, and institutions that influence innovation in the sector. While startups possessed some of this information, the assessment of sectoral TIS building blocks and influencing factors required additional knowledge. This indicates that when applying the STN model to other sectors, prior understanding of those sectors is crucial.
3. Incorporating TIS Framework into SBMC: The case studies demonstrated how integrating the TIS framework into the Sustainable Business Model Canvas (SBMC) can help startups validate their sustainable business models. This integration offers significant advantages by enabling startups to assess the readiness of their business models for the next entrepreneurial step. The TIS framework allows startups to categorize components based on their level of readiness, facilitating evaluation of different parts of their SBMC. This connection also encourages startups to critically evaluate their SBMC's scalability potential.

Niche Strategy Formation

4. Combined Niche Strategies: The formation of startup-specific niche strategies involved combining two strategies to address failing parts of the SBMC and overcome innovation barriers identified through the TIS framework. This combined strategy approach allows for more efficient targeting of weak SBMC components or lacking TIS building blocks, providing a personalized effect for each startup. Feedback from startups suggests that combining niche strategies or simultaneous implementation is already practiced by startups.

Timeline

5. Useful for Internal Communication: Feedback obtained highlighted the usefulness of the timeline for internal communication and planning during the implementation of niche strategies. The timeline helps facilitate communication

among team members and ensures a clear understanding of the strategic implementation process.

6. Iterative Revisiting: The timeline needs to be regularly revisited and updated as recommended by FOTONIQ. The startup process is dynamic, often experiencing quick changes in the business environment. Assumptions made initially may no longer hold true, while new ones may have emerged. This emphasizes the need for startups to regularly evaluate their niche strategies and make necessary adjustments to stay aligned with their goals and changing circumstances.

7.2.1 POINTS FOR IMPROVEMENT

Based on the feedback obtained from startups and the practical application of the STN model, several points for improvement have been identified:

1. Improved Guidance: Startups expressed the added benefit of having at least one person with a deep understanding of the model during its application, such as the researcher. For the general application of the model, it is important to provide a detailed guideline or booklet that offers sufficient information for its utilization. Appendix 3 can serve as a comprehensive explanation of the model's use, while Appendix 5 can provide examples of its utility.
2. Development of a Tool: Creating a tool that allows startups to automatically find appropriate niche strategies based on the status of the TIS framework would enhance the usability of the STN model. Currently, users need to manually apply the TIS framework and find suitable niche strategies using a table or similar means. Developing a tool that generates automatic suggestions for niche strategies based on the TIS framework can streamline the process. Such a tool could be built using conditional statements in Python or a similar programming language.
3. Further Automation and Integration: To improve the overall functionality of the STN model, additional automations and integrations can be implemented. The assessment of the TIS framework could be based on a sliding scale, allowing startups to rank the hindrance level of TIS building blocks. This ranking can then be used to automate the identification of potential niche strategies that best address the identified hindrances. Furthermore, TIS building blocks assessed as incompatible with the SBMC could be automatically connected to highlight possible areas for improvement and alignment. Additionally, a notification system could be integrated into the model to remind startups to plan re-evaluation dates for the timeline, ensuring regular updates and adjustments to their niche strategies.

To incorporate these improvements, more studies are needed which will be discussion in Chapter 10. These improvements can help the STN model become a more user-friendly, efficient, and comprehensive tool for startups, facilitating their decision-making processes and enhancing their sustainable business development.

7.3 GENERALE APPLICATION OF THE STN MODEL

The applicability of the STN model extends beyond the startups in the Dhc sector, as it can be used for any innovation or company in any industry. During the application of the model in the case studies, it became evident that the model has broad applicability. However, it is important for the individual applying the model to possess a sufficient level of information about the innovation, the startup, and the specific sector.

Without a comprehensive understanding of the innovation being assessed, as well as the company seeking to commercialize it, the application of the TIS framework and subsequent actions will lack meaning or value. While the assessment of the TIS framework may be based on personal reference, it highlight where the startups needs to improve and what it needs to overcome. Assessing the TIS framework based on inaccurate or incomplete information about the company or the innovation will not lead to fruitful improvements.

Furthermore, gaining a deep understanding of the particular industry or sector is essential. While a literature review and stakeholder analysis can provide valuable insights, they may not capture the nuanced tacit knowledge and intricacies associated with cultural norms and informal rules. These factors are essential for comprehending why and how socio-cultural aspects impact the innovation. Therefore, conducting interviews becomes necessary to capture these aspects and acquire a more comprehensive understanding for successful application of the TIS framework.

8. DISCUSSION

In this chapter, we will discuss the results obtained, interpret their implications, reflect on the research methods used and the feedback received from startups.

8.1 INNOVATION BARRIERS IN THE DHC SECTOR

One of the key findings of this study was the identification of innovation barriers in the Dhc sector. The list of barriers was derived from a literature review and stakeholder interviews and provides valuable insights into the challenges that sustainable startups and innovation suppliers may face in the sector. While policymakers can also benefit from this list, the focus of this study is to help sustainable startups in overcoming the barriers.

The six barriers clusters were observed from literature, which this study added to using other literature sources or interviews. It's worth noting that the studies from which this barrier list was derived used different sample sizes, methodologies, and sometimes covered different countries. Comparing and compiling these studies into a single comprehensive list may reduce its overall compatibility with the specific Dhc sector of this study. Some barriers may no longer be relevant in the Dhc sector (Kishna et al., 2011) or are not the case due to cultural or legislative differences (Kuntosch et al., 2020; Wreford et al., 2017). Previous studies have also found it challenging to define overarching barriers and adoption behaviors as newer studies often contradict older ones (Baumgart-Getz et al., 2012; Van Dijl et al., 2015; Wreford et al., 2017). This study therefore, focused more on the findings of the interviews and used the literature as guidelines and means to interpret the qualitative data and distinguish between specific barriers.

The study had limitations in terms of stakeholder representation. Interviews were conducted with a limited number of startups, innovation experts, and growers, which should be considered when interpreting the results. Nevertheless, the multi-perspective view of the barriers provided better insight into the situation. To obtain a more balanced view, it would be beneficial to include perspectives from buyers, wholesalers, and supermarkets in future research, as they play important roles in the supply chain dynamics.

The list of innovation barriers in the Dhc sector was compared to the TIS framework to assess the status of the sectoral building blocks and influencing factors. This comparison revealed the importance of understanding the Dhc innovation system for the application of the TIS framework to startups. Additionally, it highlighted which TIS building blocks and influencing factors are likely to be similarly affected across the sector. This insight can guide future sustainable startups in the sector, helping them be mindful of challenging areas, while policymakers can focus on improving those specific areas.

8.2 STN MODEL

The STN model is another key contribution of this study, which will be further discussed in this section. The STN model was developed by linking the different parts of the frameworks and canvas based on similarities and reasoning. These connections were tested in the case study application, where the identified similarities were highlighted through experimental reasoning and described in detail in Appendix 3. However, to validate each individual connection thoroughly, additional case studies might be necessary. Nonetheless, incorporating the TIS framework into the SBMC can assist startups in validating their SBMC after applying the TIS framework. The case studies presented in this study demonstrated that evaluating the upscale readiness of a startup's SBMC using this method can be highly advantageous. The TIS framework categorizes components according to their level of readiness, allowing startups to assess the readiness of different parts of their SBMC. This connection can also encourage startups to critically evaluate their SBMC's potential for scaling up. Further investigation into the use of the TIS framework to validate the SBMC, should be performed. Possible means to do so will be discussed in more detail in Chapter 10.

An additional positive effect the STN model can have is increased practical recognition for the TIS framework. Currently, the a BMC and SBMC are widely used and known in among business leaders and startups, while none of the startups of this study have previously heard of the TIS framework. By connecting the TIS framework to the SBMC, startups can leverage the strengths of both frameworks and create a comprehensive roadmap for their business growth.

9. CONCLUSION

This chapter presents the conclusions of the research conducted in this study. The study began with the formulation of three sub-questions in the introduction that would help answer the main research question. The sub-questions will be individually discussed how the results obtained from this study address the proposed sub-questions.

9.1 SUB-QUESTION 1

The primary objective of the first sub-question was to gain an understanding of the innovation system within the Dutch horticulture (Dhc) sector, where the developed model would be validated.

Sub-question 1: *"What are the barriers of the Dutch horticulture innovation system that affect the implementation of sustainable innovations in the sector?"*

To address this question, a qualitative approach was adopted, involving literature studies and semi-structured interviews with stakeholders. Through this study, a comprehensive list of barriers hindering the implementation of sustainable innovations in the Dhc sector was compiled. The individual description of each barrier can be found in Appendix 4. This list and its accompanying descriptions were instrumental in applying the TIS framework to the case study startups and gaining insights into the knowledge required for successful implementation of the framework. This, in turn, facilitates the subsequent application of the STN model to other sectors.

Chapter 4 also explains the connection between the innovation barriers in the sector and the TIS framework, as well as how the causality of the main hindering sectoral barriers can be determined. These findings are of significant value as they provide comprehensive lists of innovation barriers specific to sectors, thereby enabling startups in the sector to more readily apply the TIS framework.

9.2 SUB-QUESTION 2

The next phase of the thesis involved the development and validation of a model-based approach and tool to support sustainable startups in formulating and implementing appropriate niche strategies to enhance their business models. The second sub-question is therefore formulated as follows:

Sub-question 2*: "What are the key considerations for implementing a model-based approach to help startups adopt effective niche strategies through sustainable business models?*"

To address this sub-question, a new model was created that establishes a connection between the SBMC, the TIS framework, and niche strategies. This model has been transformed into an online tool that is freely accessible to startups across various sectors,

ensuring ease of use and accessibility. Detailed instructions on utilizing the model are provided both briefly in Chapter 5 and more extensively in Appendix 3.
The key considerations for implementing niche strategies are explored through the integration of the TIS building blocks, which are evaluated as potential obstacles or enablers within the SBMC. This analysis highlights specific areas within the business model that can be targeted by niche strategies to drive positive impact and outcomes. Moreover, in order to successfully adopt and implement niche strategies, Chapter 5 outlines how each strategy can influence the overall business model. Additionally, the model includes a timeline feature to provide a framework for the phased implementation of the niche strategies, ensuring a systematic and well-planned approach.

By integrating the SBMC, TIS framework, and niche strategies, this model-based approach equips sustainable startups with a practical tool that enables them to strategically develop and implement niche strategies to enhance their business models.

9.3 SUB-QUESTION 3

The final sub-question proposed was as follows:

Sub-question 3: *"What are the key insights from a case study application of the STN model to sustainable startups of the Dutch horticulture sector?"*

The objective of this sub-question was to assess the practical application of the STN model, evaluate its effectiveness, and identify areas for improvement. An exploratory case study methodology was employed to address this sub-question. This approach was chosen as it enables a detailed understanding of how to identify niche strategies from the TIS framework and implement them for startups.

In Chapter 6, a comprehensive explanation of the application of each step of the STN model was provided to gain insights into the workings of the model and its outcomes. The detailed description of this process for each individual startup can be found in Appendix 5. Chapter 6 illustrates how the model was applied to both startups, summarizing the results and highlighting commonalities among the obtained results.
The key insights and lessons learned from the application of the model are documented in Chapter 7. This chapter discusses the feedback received from the startups and provides recommendations for further enhancing the developed model. Notably, one of the key insights is the utility of the model in facilitating communication of niche strategies within companies and determining the optimal timing for their implementation in startups. Additionally, this study demonstrates that the STN model can be adapted for use in other sectors as long as the necessary information regarding the innovation system of the target sector is available.

By analyzing the case study application, this research sheds light on the practical implementation of the STN model for sustainable startups in the Dutch horticulture

sector. The insights gained contribute to a deeper understanding of the model's effectiveness and its potential for broader applicability, while also informing recommendations for further refinement and improvement.

9.4 ANSWERS TO MAIN RESEARCH QUESTIONS

This study aimed to answer the main research question:

"How can startups with sustainable innovations overcome barriers by means of niche strategies to implement their sustainable business model in the Dutch horticultural sector?"

To answer the main research question, this study developed a comprehensive model that assists startups in identifying and assessing innovation barriers within the TIS framework. Moreover, the model helps these startups formulate and implement niche strategies to overcome these barriers and enhance their sustainable business models.

The findings of this research highlight the crucial importance of acquiring an in-depth understanding of the specific sector when applying the model to any industry. In the context of the case study application, a thorough comprehension of the networks, cultural norms, and institutions that influence the innovation process of the startups proved essential for effectively utilizing the TIS framework. To gain the necessary insights into these aspects, this study employed stakeholder analysis and conducted qualitative stakeholder interviews, extracting tacit knowledge relevant to the sector. This approach demonstrated the specific knowledge requirements for the broader application of the model within the innovation ecosystem.

Overall, this study underscores the significance of sector-specific knowledge and the utilization of the TIS framework, and it demonstrates the value of the developed model in assisting startups in the Dutch horticultural sector and potentially beyond.

9.5 RESEARCH CONTRIBUTIONS

This section shall list and describe the contributions of this study, which has set out to contribute to the scientific literature and reduce the knowledge gap as described in Subchapter 1.1. In addition to that, this study provides actionable insights to aid sustainable startups in implementing their sustainable innovations. This study has therefore, also entrepreneurial and managerial contributions to discuss.

Scientific contribution 1: This study has provided a new model where the SBMC, TIS framework and niche strategies are connected to increase utility of niche strategies in improving business models.

This study makes a significant contribution to the scientific literature by proposing the STN model, which connects three research fields, namely SBMC, TIS framework, and niche strategies, in a novel way that has not been done before. The study goes on to validate the model for a specific sector and provide means for improvement.

Managerial contribution 1: This study has provided insight into innovation system of the Dhc sector.

By providing a comprehensive description of the Dutch horticultural sector, this study can help new startups navigate the sector and identify potential stakeholders who could provide funding, knowledge, or support for their sustainable innovations.

Managerial contribution 2: This study has provided insight into possible barriers to sustainable innovation in the Dhc sector

The study identifies and describes innovation barriers of the Dhc sector which adds to the current literature on the sector. By understanding these challenges, business leaders can take steps to mitigate them and improve their chances of success. The findings can be used to inform policies and initiatives that promote sustainable entrepreneurship and innovation. By combining existing studies and conducting interviews with various stakeholders, including sustainable startups and experts, this study provides a more comprehensive understanding of the existing innovation barriers of the sector. Previous studies did not provide an extensive list with in-depth descriptions of each of the six described barrier types (Farhangi et al., 2020; Kishna et al., 2017; Moons et al., 2022). While other studies were not specifically focused on the Dutch horticulture sector(Caldera et al., 2019; Hertel & Menrad, 2016; Kuntosch et al., 2020; Melorose et al., 2015; Wreford et al., 2017). This study's contribution to the literature is unique as it includes multiple stakeholder perspectives, reducing the bias of a single stakeholder group.

Managerial contribution 3: This study has provided examples for the application of the TIS framework and the formation of niche strategies.

This study provides future sustainable startups with two practical examples for how to apply the TIS framework to formulate niche strategies to overcome the identified innovation barriers and how to implement their sustainable innovations.

Managerial contribution 4: This study has expanded the applicability and utility of the TIS framework as a means for SBMC validation.

The TIS framework, as described by (Ortt & Kamp, 2022), has been applied to various sectors and innovations before (Vanderweyen, 2022; Wiegand & Beumer, 2020), but this study's contribution is the first application of the framework validate sustainable business models through the SBMC. The study further theorizes that the lack of assessment criteria for the TIS framework can actually benefit startups by allowing them to form their own assessment criteria at different stages of their growth. This enhanced adaptability of the TIS framework can expand its potential usefulness and contribute to the framework's potential.

Managerial contribution 5: This study has provided means for startups to implementing sustainable innovations and reduce the design-implementation gap.

The design-implementation gap is a challenge in sustainable business model innovation, which previous studies have described and tried to close (Ven, 2021; Zurkinden, 2022). By formulating niche strategies into a timeline, this study provides a practical means for startups to implement their sustainable business model innovations and prepare for future effects of the implementation. The study's findings offer concrete examples of how startups can formulate niche strategies to enter markets and implement their sustainable business models effectively.

Managerial contribution 6: This study has provided the STN model as a tool for iterative strategy formation

The study introduces the STN model, which startups can use to assess the status of their business models using the TIS framework. The model explains how to formulate and implement appropriate niche strategies, with a template for creating a timeline. By applying the model, startups can determine the potential effects of their niche strategies and communicate their plans effectively within their organization. The online tool can enables startups to continuously re-evaluate and re-adjust their strategic planning when needed.

10. REFLECTIONS AND RECOMMENDATIONS

This chapter will explore the researcher's reflections on the study and the relevance of the official examination for the Master Management of Technology. It will also discuss the research's assumptions, limitations, and conclude with recommendations for future studies.

10.1 PERSONAL REFLECTION ON MASTER THESIS

In this section, we reflect on the research process, discuss how it could have been improved with more time or different means to better meet the criteria of the Master Study in Management of Technology.

AS personal reflection, this research study has increased my appreciation for the Dhc sector and its innovative position. As a researcher, I was able to gain deep understanding of the sectors inner workings and social systems. The entrepreneurial spirit and desire for innovation despite challenges has motivated me to do my part in aiding such development. In addition, the ability to aid a multitude of startups in the YES!Delft entrepreneurial community using the STN model was the greatest motivator to finalizing this report.

Looking back at the entire proves however, it is evident that the numerous changes in research objective significantly hampered the research process. In hindsight, it might have been more beneficial to stick closer to the initial research goals, which could have reduced the time spent on report restructuring. Nevertheless, this iterative change to the research purpose resulted in the formation of the STN model, which made any additional struggle worth it.

If the study were to continue, I would delve further into the STN model and explore its practical applications for entrepreneurs in a more general sense. Should the STN model be of significant value to startups from various sectors, then it might sanction the need to write a book similar to Jak Knapp's "The Design Sprint" for the STN model.

Moreover, a significant portion of the knowledge was acquired through conversations with growers, innovation institutions, and other stakeholders in the horticulture sector. Unfortunately, much of this valuable insight was not documented and therefore could not be included in the final report. In the future, I would directly organize and conduct official interviews with stakeholders after such interactions to document these insights more effectively. This would enhance the research process and ensure that valuable knowledge is not lost.

To finalize this section, we will discuss how this study meets the criteria set by the TU Delft for a master thesis in Management of Technology (MoT). Firstly, this thesis presents a scientific study in a technological context, utilizing scientific methods such as interviews and case studies to identify and manage innovation barriers and implement niche strategies for entrepreneurs.

Secondly, the study is conducted from a corporate perspective and demonstrates an understanding of technology as a corporate resource. This study has illustrated how startups can utilize the formulated model to devise appropriate niche strategies and implement sustainable innovations, which are crucial resources for the company. Market implementation of these innovations is a vital step in overcoming the chasm of entrepreneurial challenges.

Finally, the researcher has employed scientific methods and techniques such as literature review, stakeholder interviews, and case studies to analyze a problem as presented in the Management of Technology curriculum. The MoT curriculum includes courses such as "Research Methods," "Technology, Strategy & Entrepreneurship," and "Preparation for the Master Thesis," whose knowledge has been applied in the completion of this study.

10.2 ASSUMPTIONS AND LIMITATIONS

This section will describe the assumptions and limitations of the research performed by this study per subject.

Innovation Barriers

This study aimed to identify barriers to innovation in the Dhc sector through a literature review and stakeholder interviews. However, the study had some assumptions, including extrapolating some barriers of other sectors to the Dhc sector based on commonality, without providing an indication of their severity. Although other studies have measured the severity of barriers in different sectors, it is inappropriate to assume these findings apply to the Dhc sector without conducting similar studies.

Furthermore, due to time and resource constraints, not all stakeholder groups in the supply chain could be interviewed in equal numbers. This study assumed that the most pressing barriers to innovation have been identified based on the interviews conducted with growers, startups, and experts. In addition, the growers interviewed were not selected for their variety of characteristics, but rather for their availability, as not all stakeholders wished to participate to this study, further limiting the insight gained. The views of other stakeholders, including supermarket chains, wholesale companies, and auction houses, were not fully explored, and their perspectives could have added depth to the analysis. Finally, the initial plan for this study was to develop a list of drivers of innovation in the Dhc sector. Although the interviews touched on this topic, the formation of a similar list to the barriers was not possible due to time constraints.

STN model

The STN model has several assumptions and limitations that should be acknowledged. Firstly, the TIS framework, which the model uses, has certain limitations. It is a static framework and simplifies reality, providing a snapshot that may not be effective if used only once. It is recommended that startups conduct periodic assessments as needed. Additionally, the TIS framework assumes that a technology innovation system consists of seven building blocks and seven influencing factors. However, in reality, there may be additional factors at play, and some factors may have a greater impact on each other than

on a building block. Moreover, while this study utilized the TIS framework to evaluate sustainable innovations, it was originally designed by Ortt & Kamp (2022) for radical new innovations. Therefore, we assumed its applicability to new sustainable innovations as well.

Another limitation is the unclear added value of the connection between the TIS framework and the status of SBMC within the model. It remains uncertain whether the TIS framework provides additional insights beyond what a critical examination of the SBMC can already reveal. Furthermore, the binary nature of outcome preparation in the timeline used by the STN model is a limitation. Since startups only need to prepare for two outcomes, it is highly unlikely that the actual outcome will align with the one they prepared for. However, by preparing for extreme outcomes, startups can enhance their ability to respond effectively to any outcome they encounter. Another limitation is that the current model requires a certain level of background knowledge for full comprehension, and there is currently no time-effective explanation available for individuals unfamiliar with the TIS framework or the STN model to implement them effectively together. Currently, workshops provide the most efficient means of applying the TIS framework and utilizing the STN model simultaneously.
Finally, the absence of a tool to identify niche strategies based on the TIS status is another limitation. Currently, users must manually apply the TIS framework to their company and then independently find an appropriate niche strategy.

10.3 FUTURE RECOMMENDATIONS

This section provides recommendations for future studies based on the limitations identified in the previous section.

Recommendations for the list of innovation barriers

To address the limitations the list of innovation barriers, future studies should aim to interview more actors from each stakeholder group identified in the stakeholder analysis, including those not interviewed in this study. Exploring the difference in views on the barriers formed by this study can provide deep insight into the cause and possible solutions to certain specific innovation barriers. Additionally, this study recommends further research into the severity of the found innovation barriers. An example to determine the severity it to use surveys with a point system such that the participants can grade the barriers they describe. Finally, this study recommends to add a list of drivers of innovation in the Dhc sector. This list would help future startups make use of these drivers to aid in the implementation and development of their sustainable innovations.

Recommendations for the STN model

To address the limitations and assumptions of the TIS framework, several recommendations are proposed. Firstly, future studies should examine the impact of periodic application of the TIS framework to overcome its static nature, as highlighted by Ortt & Kamp (2022). This exploration can shed light on the benefits of regularly assessing

startups' progress. It is also recommended that future research identifies assessment criteria for startups to evaluate their business status at different developmental stages. Although the study acknowledges the potential for startups to develop customized assessment criteria, further investigation into the effectiveness and practicality of such an approach would be valuable. Furthermore, exploring the positive and negative effects of combining niche approaches would be an interesting avenue for future research. While this study demonstrated a positive impact on the case study startups, it did not delve into the actual effects or provide an extensive literature review on the subject. Investigating the consequences of combining multiple niche strategies can offer valuable insights for future studies

This study also recommends further investigation into using the TIS framework for validating the SBMC. To achieve this, future studies should test a diverse range of startups with clearly defined SBMCs. A suggested approach involves dividing individuals with similar knowledge of the startups into two groups. The first group would critically assess the SBMC for potential shortcomings and then apply the TIS framework to identify any additional weak TIS building blocks. The second group would directly apply the TIS framework to evaluate the SBMC, acting as a control group. By comparing the findings of the two groups, this study can determine if the TIS framework offers novel insights into the shortcomings of the SBMC beyond what a critical analysis reveals. Such a comparative study can provide valuable insights into the effectiveness of the TIS framework as a validation tool for the SBMC.

Another recommendation for future studies is the construction of a tool that automates the process of finding niche strategies based on the TIS status. Currently, users of the STN model need to manually apply the TIS framework and find appropriate niche strategies using a table similar to Table3.1 in Chapter 3. By developing a tool that allows users to input the TIS framework into the STN model, automatic suggestions for suitable niche strategies can be generated. Such a tool could be created using conditional statements in Python or a similar programming language. However, due to time constraints, this study was unable to develop this tool, which is identified as a limitation of the STN model.

Furthermore, future studies could focus on determining if three possible future outcomes (best case, normal case, worst case) are more effective for preparation than a binary timeline. Exploring the effects of these outcomes would provide valuable insights.

The final recommendation to enhance the practical application of the STN model is to explore the possibility of formulating a list of requirements for specific niche implementations. Future studies should investigate how to convert the limitations of the SBMC and TIS building blocks into a comprehensive list of requirements. By providing startups with a list of requirements tailored to their specific challenges, this approach can improve the effectiveness of their implementation strategies.

11. REFERENCES

Al Natsheh, A., Gbadegeshin, S. A., Ghafel, K., Mohammed, O., Koskela, A., Rimpiläinen, A., Tikkanen, J., & Kuoppala, A. (2021). the Causes of Valley of Death: a Literature Review. *INTED2021 Proceedings*, *1*(March), 9289–9298. https://doi.org/10.21125/inted.2021.1943

Alkemade, F., Hekkert, M. P., & Negro, S. O. (2011). Transition policy and innovation policy: Friends or foes? *Environmental Innovation and Societal Transitions*, *1*(1), 125–129. https://doi.org/https://doi.org/10.1016/j.eist.2011.04.009

Baldassarre, B., Konietzko, J., Brown, P., Calabretta, G., Bocken, N., Karpen, I. O., & Hultink, E. J. (2020). Addressing the design-implementation gap of sustainable business models by prototyping: A tool for planning and executing small-scale pilots. *Journal of Cleaner Production*, *255*, 120295. https://doi.org/10.1016/j.jclepro.2020.120295

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17–25. https://doi.org/10.1016/j.jenvman.2011.10.006

Berkhout, P., Van Der Meulen, H., & Ramaekers, P. (2022). *Staat van Landbouw en Voedsel*. https://doi.org/10.18174/560517

Bocken, N. M. P., Schuit, C. S. C., & Kraaijenhagen, C. (2018). Experimenting with a circular business model: Lessons from eight cases. *Environmental Innovation and Societal Transitions*, *28*(February), 79–95. https://doi.org/10.1016/j.eist.2018.02.001

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Breukers, A., Hietbrink, O., & Ruijs, M. (2008). *The power of Dutch greenhouse vegetable horticulture An analysis of the private sector and its institutional framework*. *40637*, 113.

Caldera, H. T. S., Desha, C., & Dawes, L. (2019). Evaluating the enablers and barriers for successful implementation of sustainable business practice in 'lean' SMEs. *Journal of Cleaner Production*, *218*, 575–590. https://doi.org/10.1016/j.jclepro.2019.01.239

Caniëls, M. C. J., & Romijn, H. A. (2008). Strategic niche management: towards a policy tool for sustainable development. *Technology Analysis & Strategic Management*, *20*(2), 245–266. https://doi.org/10.1080/09537320701711264

Carlsson, Elg, L., & Jacobsson, S. (2010). *Chapter 7: Reflections on the Co-evolution of Innovation Theory, Policy and Practice: The Emergence of the Swedish Agency for Innovation Systems*. Edward Elgar Publishing. https://doi.org/10.4337/9781849804424.00014

Carlsson, & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics*, *1*, 93–118.

Ching, P. H. Y., & Fauvel, C. (2013). CRITICISMS, VARIATIONS AND EXPERIENCES WITH BUSINESS MODEL CANVAS. *European Journal of Agriculture and Forestry Research*, *1*(2), 26–37.

Elkington, J. (1998). Accounting for the triple bottom line. *Measuring Business Excellence*.

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business Model Innovation for Sustainability: Towards a Unified

Perspective for Creation of Sustainable Business Models. *Business Strategy and the Environment*, *26*(5), 597–608. https://doi.org/10.1002/bse.1939
Farhangi, M. H., Turvani, M. E., van der Valk, A., & Carsjens, G. J. (2020). High-tech urban agriculture in Amsterdam: An actor network analysis. In *Sustainability (Switzerland)* (Vol. 12, Issue 10). https://doi.org/10.3390/SU12103955
Franck, A., & Nemes, I. (2017). *Dutch Supermarket Supply Chains*. https://doi.org/10.21201/2017.1626
Gbadegeshin, S. A., Al, A., Ghafel, K., & Mohammed, O. (2022). *Overcoming the Valley of Death : A New Model for High Technology Startups*. *4*(March). https://doi.org/10.1016/j.sftr.2022.100077
Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, *33*(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015
Geels, F. W., Hekkert, M. P., & Jacobsson, S. (2008). The dynamics of sustainable innovation journeys. *Technology Analysis & Strategic Management*, *20*(5), 521–536. https://doi.org/10.1080/09537320802292982
Geissdoerfer, M., Bocken, N. M. P., & Hultink, E. J. (2016). Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. *Journal of Cleaner Production*, *135*, 1218–1232. https://doi.org/10.1016/j.jclepro.2016.07.020
Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240
Geissdoerfer, M., Vladimirova, D., Fossen, K. Van, & Evans, S. (2018). Product, service, and business model innovation: A discussion. *Procedia Manufacturing*, *21*, 165–172. https://doi.org/10.1016/j.promfg.2018.02.107
Hertel, M., & Menrad, K. (2016). Adoption of energy-efficient technologies in German SMEs of the horticultural sector—the moderating role of personal and social factors. *Energy Efficiency*, *9*(3), 791–806. https://doi.org/10.1007/s12053-015-9400-0
Jacobsson, S., & Karltorp, K. (2013). Mechanisms blocking the dynamics of the European offshore wind energy innovation system – Challenges for policy intervention. *Energy Policy*, *63*, 1182–1195. https://doi.org/https://doi.org/10.1016/j.enpol.2013.08.077
Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, *135*, 1474–1486. https://doi.org/10.1016/j.jclepro.2016.06.067
Jukema, G. D., Ramaekers, P., & Berkhout, P. (2020). De Nederlandse agrarische sector in internationaal verband. *Wageningen Economic Research En Centraal Bureau Voor de Statistiek*, *1*, 1–172.
Kamp, L. M., Smits, R. E. H. M., & Andriesse, C. D. (2004). Notions on learning applied to wind turbine development in the Netherlands and Denmark. *Energy Policy*, *32*(14), 1625–1637. https://doi.org/https://doi.org/10.1016/S0301-4215(03)00134-4
Kamp, L. M., & Vanheule, L. F. I. (2015). Review of the small wind turbine sector in Kenya: Status and bottlenecks for growth. *Renewable and Sustainable Energy Reviews*, *49*, 470–480. https://doi.org/https://doi.org/10.1016/j.rser.2015.04.082
Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management,.

Technology Analysis & Strategic Management, *10*(2), 175–198. https://doi.org/DOI: 10.1080/09537329808524310

Kishna, M. J., Alkemade, F., Negro, S. O., & Hekkert, M. P. (2011). Het innovatiesysteem van de Nederlandse glastuinbouw in 2020: marktgerichte innovatiestrategieen. *Rapport 11.2. 275*, 1.

Kishna, M. J., Negro, S., Alkemade, F., & Hekkert, M. (2017). Innovation at the end of the life cycle: discontinuous innovation strategies by incumbents. *Industry and Innovation*, *24*(3), 263–279. https://doi.org/10.1080/13662716.2016.1226163

Kuntosch, A., König, B., Bokelmann, W., Doernberg, A., Siebert, R., Schwerdtner, W., & Busse, M. (2020). Identifying system-related barriers for the development and implementation of eco-innovation in the german horticultural sector. *Horticulturae*, *6*(2), 1–21. https://doi.org/10.3390/horticulturae6020033

Logatcheva, K. (2022). Monitor Duurzaam Voedsel 2021: Consumentenbestedingen. *Wageningen Economic Research*, *2022–098*, 1–18.

Lukkarinen, J., Berg, A., Salo, M., Tainio, P., Alhola, K., & Antikainen, R. (2018). An intermediary approach to technological innovation systems (TIS)—The case of the cleantech sector in Finland. *Environmental Innovation and Societal Transitions*, *26*(June 2016), 136–146. https://doi.org/10.1016/j.eist.2017.04.003

Malerba, F. (2002). Sectoral systems of innovation and production. *Research Policy*, *31*(2), 247–264. https://doi.org/https://doi.org/10.1016/S0048-7333(01)00139-1

Markham, S. K., Ward, S. J., Aiman-smith, L., & Kingon, A. I. (2010). *The Valley of Death as Context for Role Theory in Product Innovation*. 402–417.

Massa, L., & Tucci, C. L. (2013). Business model innovation. *The Oxford Handbook of Innovation Management*, *20*(18), 420–441.

Melorose, J., Perroy, R., & Careas, S. (2015). Sustainable horticulture: understanding barriers to the adoption of innovation. *Statewide Agricultural Land Use Baseline 2015*, *1*, 1446–1452.

Minatogawa, V., Franco, M., Rampasso, I. S., Holgado, M., Garrido, D., Pinto, H., & Quadros, R. (2022). Towards Systematic Sustainable Business Model Innovation: What Can We Learn from Business Model Innovation. *Sustainability (Switzerland)*, *14*(5). https://doi.org/10.3390/su14052939

Mitchell, D., & Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. *Journal of Business Strategy*, *21*(5), 15–21.

Moons, I., De Pelsmacker, P., Pijnenburg, A., Daems, K., & Van de Velde, L. L. J. (2022). Growers' adoption intention of innovations is crucial to establish a sustainable greenhouse horticultural industry An empirical study in Flanders and the Netherlands. *Journal of Cleaner Production*, *330*(May 2021), 129752. https://doi.org/10.1016/j.jclepro.2021.129752

NAGF. (2019). *Ga voor kleur LAB, kleurrijke verleidingen in de supermarkt stimuleert de verkoop van groenten en fruit*. https://nagf.nl/assets/Uploads/ccf9da0d63/rapport-nagf-vu-ga-voor-kleur-lab- 2019.pdf

Negro, S. O., Alkemade, F., & Hekkert, M. P. (2012). Why does renewable energy diffuse so slowly? A review of innovation system problems. *Renewable and Sustainable Energy Reviews*, *16*(6), 3836–3846. https://doi.org/10.1016/j.rser.2012.03.043

Nidumolu, R. (2009). Why Sustainability is the key driver of innovation. *Harvard Business Review*, 57–64.

NOS. (2019). Vleesvervangers bezig met snelle opmars, verkoop vlees daalt. *NOS.Nl*. https://nos.nl/artikel/2297492-vleesvervangers-bezig-met-snelle-opmars-verkoop-vlees-daalt

Nosratabadi, S., Mosavi, A., Shamshirband, S., Zavadskas, E. K., Rakotonirainy, A., & Chau, K. W. (2019). Sustainable business models: A review. *Sustainability (Switzerland)*, *11*(6), 1–30. https://doi.org/10.3390/su11061663

Ortt, J. R., Kamp, L., Bruinsma, V., & Vintila, S. (2015). Subsequent Niche Strategies for High-tech Products during Market Formation. *ISPIM Innovation Symposium*, *December*, 1. www.ispim.org.

Ortt, J. R., & Kamp, L. M. (2022). A technological innovation system framework to formulate niche introduction strategies for companies prior to large-scale diffusion. *Technological Forecasting and Social Change*, *180*(April), 121671. https://doi.org/10.1016/j.techfore.2022.121671

Ortt, J. R., Langley, D. J., & Pals, N. (2013). Ten niche strategies to commercialize new high-tech products. *International Conference on Engineering, Technology and Innovation (ICE) & IEEE International Technology Management Conference*. https://doi.org/10.1109/ITMC.2013.7352687.

Ortt, J. R., & van der Duin, P. A. (2008). The evolution of innovation management towards contextual innovation. *European Journal of Innovation Management*, *11*(4), 522–538. https://doi.org/10.1108/14601060810911147

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation. In *Business Model Generation* (pp. 14–56). John Wiley and Sons Inc. https://books.google.nl/books?id=L3TnC7ZAWAsC&printsec=frontcover&hl=nl&source=gbs_atb#v=onepage&q&f=false

Richardson, J. E. (2008). The Business Model: An Integrative Framework for Strategy Execution. *SSRN Electronic Journal*, 1–27. https://doi.org/10.2139/ssrn.932998

Ritala, P., Huotari, P., Bocken, N., Albareda, L., & Puumalainen, K. (2018). Sustainable business model adoption among S&P 500 firms: A longitudinal content analysis study. *Journal of Cleaner Production*, *170*, 216–226. https://doi.org/10.1016/j.jclepro.2017.09.159

Schoormans, M., & Rabensbergen, P. (2022). Hoe kan de concurrentiepositie en innovatiekracht van het Nederland gevestigde leden behouden worden ? *Horticulture Tomorrow*, 1–13.

Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management*, *20*(5), 537–554. https://doi.org/10.1080/09537320802292651

Schout, H. J., & Harkema, S. J. M. (2012). Green networks: Innovative capacity of SMEs in the Dutch greenhouse horticulture industry. *Applied Studies in Agribusiness and Commerce*, *6*(1–2), 43–50. https://doi.org/10.19041/apstract/2012/1-2/5

Seers, K. (2015). Qualitative systematic reviews: Their importance for our understanding of research relevant to pain. *British Journal of Pain*, *9*(1), 36–40. https://doi.org/10.1177/2049463714549777

Stubbs, W., & Cocklin, C. (2008). Conceptualizing a “sustainability business model.” *Organization and Environment*, *21*(2), 103–127. https://doi.org/10.1177/1086026608318042

Van Dijl, E. A., Grogan, K. A., & Borisova, T. (2015). Determinants of adoption of drought

adaptations among vegetable growers in Florida. *Journal of Soil and Water Conservation*, *70*(4), 218–231. https://doi.org/10.2489/jswc.70.4.218
Vanderweyen, G. (2022). *A niche introduction strategy for large scale diffusion of Food Hubs in European urban*. *November*.
Ven, J. van der. (2021). *Bridging the design-implementation gap of Sustainable Business Model Innovation*.
Verburg, R. (2017). *MoT Thesis Requirements*. GreatLibrary.com. https://greatlibrary.nl/content//MOT_Thesis_Requirements.mp4
Vijverberg, A., Immerzeel, T., van Dam, C., & van der Leest–Brand, D. (2007). Hoofdstuk 6. Glastuinbouw. In *Kassen in Nederland* (pp. 415–508).
Wieczorek, A. J., & Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, *39*(1), 74–87. https://doi.org/10.1093/scipol/scr008
Wiegand, M., & Beumer, K. (2020). *The Role of the Emerging Aquaponics Technology and the Transition towards Sustainable Agriculture*. 1–121.
Wijnands, J. H. M. (2005). *Sustainable International Networks in the Flower Industry : bridging emperical findings and theoretical approaches*. *2*, 92. http://library.wur.nl/edepot/34970
Willoughby, R., & Gore, T. (2018). *Ripe for change*. https://doi.org/10.21201/2017.1787
Wreford, A., Ignaciuk, A., & Gruère, G. (2017). Overcoming barriers to the adoption of climate-friendly practices in agriculture. *OECD Food, Agriculture and Fisheries Paper*, *101*(101). https://doi.org/10.1787/97767de8-en
Zott, C., Amit, R., & Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management*, *37*(4), 1019–1042. https://doi.org/10.1177/0149206311406265
Zurkinden, L. (2022). Organizational culture: A tool for bridging the design–implementation gap of sustainable business model innovation. *Https://Doi.Org/10.1080/26437015.2021.1989636*, *3*(3), 246–254. https://doi.org/10.1080/26437015.2021.1989636

APPENDIX 1: INTERVIEWS

For the interviews varying perspectives were targeted to obtain a more broad insight into the sector. Three main groups can be identified amongst the interviewees, namely the growers, sustainable startups and experts of innovation institutions specifically for the Dutch horticultural sector.
Per group of interviewees, different questions were asked. In the following section, the list of questions asked to the three groups of interviewees are given.

A1.1 INTERVIEW QUESTIONS

1. Could you give a brief introduction about your company and your role within the company?
2. What does the term "sustainable innovation" mean to you and your company?
3. What sustainable innovations has your company recently introduced and can you briefly explain them?
4. What is important for you to consider when deciding to adopt a new innovation in your company: 1) the cost-effectiveness, 2) the effect on the sustainability of the company, 3) the automation of the innovation, or 4) the success of the innovation at other growers?
5. What are the main reasons for you to purchase a new sustainable innovation?
6. Do you reach out to other growers when considering the purchase of a new sustainable innovation?
7. If so, who do you reach out to?
8. With your recent sustainable purchase, how did you determine the potential benefits of the purchase?
9. Are you satisfied with the purchase? Did the effects meet your expectations? How do you evaluate its success?
10. What has motivated you the most to invest in sustainable innovations? (E.g., competition pressure, economic pressure, internal motivation to become more sustainable, government assistance?)
11. What has helped you the most to purchase and install sustainable innovations as quickly and efficiently as possible?
12. How do you become aware of the existence of new sustainable techniques?
13. Have you recently rejected a sustainable innovation or decided not to invest in it? If so, what was the decisive factor in not choosing it?
14. What has most hindered you in purchasing other sustainable innovations? (What barriers have you experienced?)
15. To what extent have these barriers played a role in rejecting other/multiple sustainable initiatives? Do the barriers occur frequently?
16. To what extent do you expect these same factors to influence other growers?

A1.2 INTERVIEW QUOTES

Table A1.1 Quotes of growers

Grower ID	Quotes	Barriers mentioned
Grower 1	The Dhc sector is in part so good because a lot is outsourced. The growers only need to focus on production and cultivation, sales and marketing is not needed due to the retail. But that's the problem, everything is anonymous. The customers don't even know the names of any of the biggest growers in the Netherlands. This is also the problem. If you're not at the dinner table, you're lunch. The growers have no power in the supply chain, therefore lack any possible actions to perform actions that might influence the price of their products. Additionally, if a grower cultivates with more sustainable methods or not, is unknown. So there is no direct benefit for them. We are in the beneficial position that we have a near monopoly in our crops type. This allows us to look farther in the future than others. As such, we also aim to be the example for carbon neutral cultivation. Sustainability is a term used too much, there is no value in the word anymore. For us, we try to recalculate everything to its CO2 equivalent. Thereby, it becomes possible to determine what tasks, actions or resources take allot of CO2 to mitigate it as much as possible. You notice that tech companies tell the story differently, growers need to feel what happens to the greenhouse and their plants, before anything else. The government changes like the weather, you can't be sure if the wind ever blows your way. Some years ago, we tried a new method of sustainable cultivation which would reduce allot of our CO2 emissions, but the legislation in place was not up to date. As a result, we had to take down out top- of-the- line sustainable equipment to go back to more environmentally straining cultivation.	No power in supply chain No direct benefits from investments into sustainable methods. Communication barrier with tech companies Governmental policies not up-to date
Grower 2	Sustainability is such a popular word, for me if I do better than my neighbor using the same resources, then it will be more sustainable. you have to change if you don't and your neighbor overtakes you, it'll be you that fails and him to overtake you. You see that even for the LED investment, there is still discussion over the best settings and color of the light. An that is after several years of research. For anything being introduced now, you can bet that the timeline will look similar or larger rather than shorter. Even if your plants have higher quality, you won't get any added value. You only will be sure you'll be able to sell them.	Financial instability No faith in sustainability claims Competing pressure No beliefs in scientific statements Perceived long time horizons First mover fear Lack of any benefits

Grower 3	With the current inflation, you have to find new ways to reduce OPEX to lower the risk. If another change happens, due to politics of whatever, your business might not survive. You often come across new innovations, but the ones that you can actually purchase and implement successfully are limited. It is important to take into account your own financial situation and the time required for installation and optimal functioning of these systems. You can't do everything at once.	Effects on production cost Political uncertainty Limited financial means Limited means Cost of adoption and optimization Time constrains
Grower 4	if you save too much, even by a little, your production will suffer. Because if you don't move forwards, you will move backwards in respect to the others. Once that happens, you'll lose more than you could save. it's difficult to implement the new innovations quickly. Even something as LED lights, it's just not possible, financially and physically, to change all your light bulbs at once, especially before the start of a new harvest/planting cycle. You need to keep the crops going. If it takes too long, you risk your harvest, and that is never an option. Also, I'm getting older. At some point, you don't want to add too much to your already full plate.	Time constrains, Tenure Personal ability Effect on production
Grower 5	We can still make enough money using the WKK, while maximizing gas consumption. But you also want to have a sense of pride when you come home. You want to have the feeling you did something right at the end of the day. You can see even small changes or investments have many varying changes in the greenhouse, just a couple LED lights change the temperature provide, growth, humidity etc. At the end of the day, the best producers stay in the game, best adapt to the neighbors. For things like LED, its been in the loop for so long, so you know what to expect long before you get the first boxes in. For the newer innovations, you don't have such a protocol list yet. Those who stand still, are overtaken. Every investment MUST bring you forward, else there is no point. in regards to geothermal energy, it's a big investment. With the current political climate, you must be certain to even exist by the time it could pay back.	Personal ability Cultural capital Effects on production First mover fear Perceived long time horizons Time constrains Competing pressures Political uncertainty
Grower 6	It's better to see what the others think of the product and how they incorporate it into their cultivation methods. Rather you wait until the technique is far enough that you only need to invest once, instead of reupdate every so many years. You can't allow to increase your OPEX too much, otherwise your prices will increase and you'll lose sales	First mover fear Effect on Product Price Power in supply chain Cost of adoption Risk management Mark of approval, Cultural capital

Table A1.2 Quotes of entrepreneurs

ID	Quotes	Barriers mentioned
Entre-preneur 1	Once you found a partner who believes in your story, its easy to find many others. Selling the story is not the hard part, getting it in the greenhouse on the right scale is 4 years ago, we were almost laughed at for saying we wanted to reduce fossil fuel consumption, now their stance is much different Growers have a healthy resistance to scientific research. So you cannot convince them with a study from Wageningen University. It helps, but it's not everything. Because every grower says, in such research, it's different than in practice and in the operational large-scale greenhouse. Priva and Delphy want to provide scientific findings to implement new methods of cultivation, while growers don't always want to accept them. They are dependent on energy suppliers and they are already used to this method, why change? It almost impossible to drastically change cultivation methods for a whole greenhouse at once. The growers and the crop need time to adapt and adjust. If the crops are endangered during the adaption period, the grower might be faced with bankruptcy overnight. The growers want to help design and think along, but anymore is often too much. For startups in this sector, getting a mark of approval for a true scale greenhouse is the most important thing. Without it, you won't be selling anything yet. The Dhc sector is a sector in which change can take years, if you compare that to other consumer sectors, change can happen in months, so you better strap in.	Greenhouse size Financial instability Political uncertainty Hesitance of scientific findings, Culture difference Risk averse Lack of focus on sustainability Fear for crops safety Cultural capital Long time horizons Cost of adoption Time constrains
Entre-preneur 2	Growers do want to innovate, but not be the one to carry the risk (be it financial or for their crops) the inflation of energy and gas is great for us, but only if the grower is still financially stable to innovate still some growers proudly state how 2024 will be the most profitable year in they lives, and want to convert those earnings and reinvest The sizes and efficiency of the greenhouses have increased so much, getting the chance to run some tests in such a well-oiled machine is hard to obtain. You can't just place your innovation there, because everything has influence on something. For a pilot test, you need to invest 250k minimum on the prototype, being told they don't want to carry any financial risk even then, is difficult to manage. The growers have a healthy resistance against scientific findings of WUR or others. As they say, such scientific setups are greatly different from a greenhouse, where everything is interconnected. A test setup in a 500m2 greenhouse can hardly be compared to a 4 ha greenhouse	Risk averse Financial stability Cultural capital Cost of adoption Greenhouse size Culture difference, lack of trust in scientific findings Political uncertainty Lack of financial benefits Long time horizons

	Growers are afraid of the coming carbon tax. If they invest in anything with a 10+ payback time, what if they don’t exist then due to the carbon tax?	

Table A1.3 Quotes of experts

Expert ID	Quotes	Barriers mentioned
Expert 1	The strength of the sector and the growers is their ability to communicate and collaborate when the need arises. so much has changed in the last 5 years, its difficult to imagine what the next 5 will bring Growers used to be very conservative, now that has changed allot. Possibly due to the current competing pressures the growers face, which has made them see the need to innovate. Everyone has to consider sustainability, but how that translate for the consumer is still difficult to discern. Biggest hinderances we hear are; budgets time and potential danger for crops Growers cultivating fresh product often focus on tomorrow, with less view of longer time horizons.	Risk averse growers, Conservative Financial means Time constrains Potential effects on crops/ production Personal Infrastructure
Expert 2	Growers don't always have a focus on sustainability, so why worry over it. Main focus is on production and harvest It's not from a lack of wanting, more a lack of know-how. A sense of pressure won’t be felt until they are affected by the consequences in some way High tech companies also focus on solving problems growers have no knowledge of or experience The growers don't always want to lose the tasks they perform due to automatization. Some like their morning routines the way they are, if you remove those steps by making a machine to replace them, then the growers will lose a sense of ownership over their work Sustainability is a difficult thing to truly label, how far will you look. is one thing really better than the other?	Lack of focus or knowledge regarding sustainability Lack of understanding of high tech innovations or the problems Culture difference; not all improvements are 'problem'' oriented for the growers Cultural Capital, Sense of ownership
Expert 3	The Dhc sector is difficult to enter the market, no grower want to be the first to adopt a new innovation but everyone want to be the second. Some growers already know that 2024 will be their most lucrative year of their lives. This means they need to look for ways to capitalize on them. The other grower who do not have a fixed gas contract are facing financial struggles so they are not able to take on any investments. Its difficult for startups to test their products on such a large greenhouse to gather enough evidence of success. Growers don’t want to have other experiment with their greenhouses or crops, but also will not take any innovations which aren’t field tested. This is a difficult loop to break sometimes.	First adoption fear Financial struggles Greenhouse sizes Risk averse

Expert 4	If there is a big enough need or crisis, the sector can innovate frighteningly fast, look at the water cultivation method, it took less than a month to fix once it was truly necessary. The next crisis will likely be regarding nutrients and substrates for growth Growers need to learn to publicize their problems so that the technology companies know what to solve. Growers are still conservative, but with reason. In the past, some growers have failed due to failing innovations, that is no longer the case, also due to the fact that growers need 100% certainty before adopting any innovation. The growers have become dependent on others for their innovations, the growers need to adapt to that fact still. the consumer has be taught for generations that the best product is the one for the lowest price, not the one made with the most sustainable methods. It will take a long time with numerous marketing campaigns to change their view and priorities when shopping. You should expect more from the R&D of growers accusations. Their presence and power is increasing, but the R&D output is not living up to their potential. Culture of growers in other countries is vastly different, there they are much more willing and eager to invest in new innovations. The Dhc sector will likely be surpassed soon if nothing changes.	Culture difference, Conservative Distrustful toward scientific findings Risk averse, they need 100% guarantee Power in supply chain First mover fear Past experiences Lack of benefit for sustainability Conflict of interests with policy makers (sometimes strong, other times weak) Current climate policy Customer behavior

A1.3 INNOVATION BARRIERS IN THE DHC SECTOR

In this sub chapter, our main objective is to provide a detailed description of the individually found barriers that hinder the implementation of sustainable innovation in the Dhc sector (Table 4.1).

Individual barriers

There are various barriers that hinder the adoption intention of growers, which stem from their individual circumstances. These barriers relates to the personal capabilities of the growers and encompass several factors such as the growers' age, tenure, experience, workforce size, financial resources, and expertise (Expert 2, Appendix 1). Studies indicate that older growers are generally less inclined to embrace new technologies or cultivation methods (Caldera et al., 2019; Moons et al., 2022; Wreford et al., 2017). Younger growers are more receptive to adopting innovative practices. During the interviews, only one grower expressed *"...I'm getting older. At some point, you don't want to add too much to your already full plate"* (Grower 4, Appendix 1).

The successful adoption of new technologies depends not only on age but also on factors such as the growers' experience, workforce size, financial resources, and expertise (Expert 2, Appendix 1) (Moons et al., 2022). As Grower 4 described, you not only need to adopt the innovation itself, it needs to be done fast enough to not hamper the new cycle for harvest. "...*If your adoption takes too long, you risk harvest, and that is never an option*" (Grower 4 Appendix 1). As such Caldera et al., (2019) identified how certain organizational structures of growers may hamper the ability to implement new innovations in their greenhouses. Similarly another grower stated that; *"At the end of the day, the best producers stay in the game"* (Grower 5, Appendix 1). Other sources also mention that a lack of succession planning in the business can act as a barrier to innovation adoption (Moons et al., 2022). According to Fischer & Burton (2014), some growers do not have a successor or any succession plans, which can impede the adoption of innovations. Although this aspect was not explicitly mentioned in the interviews, it aligns with the personal capabilities mentioned earlier.

The final personal barrier relates to the local infrastructure and complementary inputs surrounding the greenhouse (Caldera et al., 2019; Kishna et al., 2011; Kuntosch et al., 2020; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017). While this barrier was not specifically highlighted in the interviews, it does indicate the historical lack of collaboration within the sector, as mentioned by Expert 1 (Appendix 1). Expert 1 discussed how, in the past, limited collaboration and communication hindered the diffusion of innovation and knowledge sharing significantly, but the situation has changed significantly in recent years. However, literature provides an interesting example of this barrier. An illustrative case is the integration of geothermal energy into greenhouses, which requires networks of dedicated pipes buried near the greenhouse (Geothermie.nl, 2023).The associated injection point also needs to be in close proximity, varying from one grower to another. Depending on the specific requirements of an innovation, this barrier can have varying effects.

Financial barriers

Financial barriers were consistently mentioned by the interviewed stakeholders and found in the majority of the literature studies. Particularly for sustainable innovations, growers may struggle to perceive immediate financial benefits. Consequently, one significant financial barrier is the perceived lack of financial benefits. The measurable relief of financial costs or increased production serves as a crucial motivator for growers to invest. The absence or perceived absence of such benefits hinders the implementation of innovations (Caldera et al., 2019; Kuntosch et al., 2020; Melorose et al., 2015; Wreford et al., 2017). Expert 4 also discussed this issue, stating that there is no benefit for growers to adopt more sustainable production methods because "*… the consumer has be taught for generations that the best product is the one for the lowest price, not the one made with the most sustainable methods*" (Expert 4, Appendix 1). Grower 2 mentioned *"… even if your plants have higher quality, you won't get any added value*" (Appendix 1). Melorose et al., (2015) similarly described how consumers are unwilling to pay premium prices for more sustainably made or higher-quality products.

Another financial barrier is the lack of financial means to invest in some or all sustainable innovations (Caldera et al., 2019; Farhangi et al., 2020; Kuntosch et al., 2020; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017). Growers have limited budgets available for investment in innovations, making it impossible to adopt all sustainable innovations simultaneously. Geothermal energy integration provides an example of this. Specialized equipment for precision irrigation is another instance of a sustainable innovation with high investment costs. While greenhouse growers have separate budgets for investment in innovations and benefit from governmental subsidies, some adoption costs exceed the financial capacity of small to medium-sized companies. Growers often implement certain innovations in stages. For example, many growers gradually transition to LED lights. According to Grower 4; "*Even something as LED lights, it's just not possible, financially and physically, to change all your light bulbs at once, especially before the start of a new harvest/planting cycle* "(Grower 4, Appendix 1). Recent inflation, particularly in gas and electricity prices, has further strained the finances of some growers. As Expert 3 stated; *"The other grower who do not have a fixed gas contract are facing financial struggles so they are not able to take on any investments"* (Grower 3, Appendix 1). Without a stable financial situation, growers are unable to invest in new innovations, impeding implementation. Sustainable startups should therefore target growers with sufficient financial means to afford such investments.

Another financial barrier is the cost of adopting sustainable innovations (Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017). While the implementation of certain innovations may be straightforward, most new technologies require time and knowledge to be effectively integrated into the existing greenhouse system. For example, Grower 5 mentioned how "*… just a couple LED lights change the temperature provide, growth, humidity etc.*"(Grower 5, Appendix 1). Most mentioned economic cost are based on average values which do not account for the heterogeneity of greenhouses (Wreford et al., 2017). These hidden transition costs associated with learning and implementing new technologies were first identified by Moran et al., (2013) and form an important part of the financial barriers. Something similar was mentioned by Grower 6, who stated the " *Rather you wait*

until the technique is far enough that you only need to invest once, instead of reupdate every so many years." (Grower 6, Appendix 1). Additionally, there is always a potential risk of negatively impacting the crops, which requires time to mitigate. As Entrepreneur 1 stated: *"If the crops are endangered during the adaption period, the grower might be faced with bankruptcy overnight"* (Entrepreneur 1, Appendix 1).

This directly relates to the final financial barrier, which is the potential effect on production that new innovations might have (Caldera et al., 2019; Melorose et al., 2015; Moons et al., 2022; Wreford et al., 2017). This is a fear expressed by almost every grower. Any potential threat to the crops or production will have severe negative consequences for the growers. Consequently, if there is a perceived risk to production, the innovation will not be considered due to the associated uncertainty. Entrepreneur 2 faces significant challenges in this regard. Although their findings indicate that their innovation will increase production, growers are still hesitant, fearing a potential reduction in production instead. Therefore, sustainable startups must acknowledge these barriers. They need to demonstrate the impact of their innovation on potential production and effectively communicate this information. Otherwise, their innovations will face resistance from growers who firmly believe that *"every investment MUST bring you forward, else there is no point"* (Grower 5, Appendix 1).

Social and cultural barriers

The first barrier is cultural capital (Moons et al., 2022; Wreford et al., 2017). Being a grower holds a sense of identity and status within themselves and their communities. Many growers come from a family of farmers or growers, which instills a strong connection to the profession with social and cultural capital. Expert 2 highlighted in the interview that certain growers *"...don't always want to lose the tasks they perform due to automation. Some enjoy their morning routines the way they are, and if you replace those steps with machines, growers may feel a loss of ownership over their work"* (Expert 2, Appendix 1). Similarly, Dutch growers share a cultural connection that unites them. When one grower adopts a new innovation, it becomes a symbol of approval. Consequently, when a neighboring grower implements a certain practice or technology, others are more likely to follow suit (Kuhfuss et al., 2016). This approval serves as a filter. *"Once you find a partner who believes in your story, it's easy to find many others"* (Entrepreneur 1, Appendix 1). However, sustainable startups may face difficulties entering the market without this mark of approval, as other growers are hesitant to try an innovation without it. They prefer to observe what others think of the product and how it fits into their cultivation methods (Grower 6, Appendix 1).

This ties into the next barrier, the first mover fear(Kishna et al., 2011; Moons et al., 2022). Growers are often unwilling to be the first to adopt a new technology or cultivation method that has not been implemented in other greenhouses yet. This sentiment is expressed not only by growers but also by experts and entrepreneurs in the sector (Table 5.1). Part of this reluctance stems from the intense competitive pressure in the industry, as well as the fear of jeopardizing their harvest (Melorose et al., 2015). Expert 3 stated; *"Growers don't want to have other experiment with their greenhouses or crops, but also will not take any innovations which aren't field tested. This is a difficult loop to break sometimes"* (Expert 3, Appendix 1).

Moons et al., (2022) also highlighted that growers who had failed past experience of an innovation will refrain from trying out another time. In their study was stated that such growers feel that 'being too early' was a mistake and will in the future wait for more conclusive results. This closely aligns with the fear of being the first mover, as the initial adopter carries the highest level of risk. Similarly, Expert 4 described that growers *"have failed due to failing innovations, that is no longer the case, also due to the fact that growers need 100% certainty before adopting any innovation"* (Expert 4, Appendix 1). While these past failures may no longer result in business failures for growers, they can still impact their perception of new innovations. Therefore, sustainable startups should be aware that some growers may still have doubts based on their own or their colleagues' past failures.

The final social cultural barrier is the lack of cross-sector communication and coordination. With technological advancements, horticultural innovations have shifted from being driven by the growers themselves to technological companies (Expert 2 and Expert 4, Appendix 1). Currently, most innovations in the horticultural industry originate from other sectors (Kuntosch et al., 2020). This cultural difference between sectors hampers the implementation of innovations. Technological innovators have different priorities for improvement, which may not align with the growers' perceived problems. As Grower 1 stated : *"You notice that tech companies tell the story differently, growers need to feel what happens to the greenhouse and their plants, before anything else"* (Grower 1, Appendix 1). Additionally, according to Melorose et al., (2015), growers feel a lack of confidence in the results of these technologies. Entrepreneur 1 mentioned that Dutch growers have a healthy skepticism towards scientific research (Entrepreneur 1, Appendix 1). While institutions such as WUR, Priva, and Delphi aim to provide scientific papers to improve the industry, growers feel that these studies do not fully represent the greenhouse environment. Expert 2 believes that innovations from other sectors will be increasingly important in the future, particularly in areas such as cybersecurity, and active efforts are being made to improve the implementation of such innovations in the sector. However, in order to enhance the chances of adoption, startups should learn effective communication strategies to convey their innovations to growers. Simultaneously, it will be crucial for growers to openly communicate their challenges, enabling technology companies to better understand and address their needs (Expert 4, Appendix 1).

Behavioral and cognitive barriers

Behavioral and cognitive barriers play a significant role in the adoption of sustainable practices in greenhouse cultivation. One of these barriers are the beliefs about climate change and sustainability (Kuntosch et al., 2020; Moons et al., 2022; Wreford et al., 2017). Wreford et al., (2017), highlights that growers may underestimate their own greenhouse gas emissions while also perceiving that their individual actions won't make a difference unless other farmers also take similar steps (Greiner and Gregg, 2011). Additionally, farmers' perception of their own ability to adapt to climate change impacts is crucial. Similarly, the interviews conducted by Moons et al. (2022) reveal that growers feel that the term "sustainability" has become overused in the industry, diminishing its value. As one grower expressed, *"Sustainability is a term used too much, there is no value in the word anymore"* (Growers 1, Appendix 1). The debate over what constitutes sustainability, such

as whether tomatoes grown abroad or under artificial light are more sustainable, further highlights the uncertainty surrounding the concept. As expressed by Grower 2, *"for me if I do better than my neighbor using the same resources, then it will be more sustainable "* (Grower 2, Appendix 1). Despite the proliferation of innovations claiming to promote sustainability, growers still prioritize their own production efficiency, creating a conflict of interest. This is an important consideration for future sustainable startups to keep in mind.

Another cognitive barrier is the perceived long time horizon (Caldera et al., 2019; Farhangi et al., 2020; Wreford et al., 2017). As emphasized by experts and entrepreneurs in the sector, it takes considerable time for innovations to be embraced by greenhouse growers. For instance, LED lights were first introduced for greenhouses in the early 2000, and still not all greenhouses have adopted this technology (Katzin, 2021). Grower 2 stated that "*For anything being introduced now, you can bet that the timeline will look similar or larger rather than shorter"* (Grower 2, Appendix1). This sentiment is shared throughout the sector, as it is physically and practically challenging to rapidly implement new innovations across large-scale greenhouses. "*It's nearly impossible to revolutionize cultivation methods for an entire greenhouse all at once*" (Grower 2, Appendix 1). Moreover, government policies pressuring for sustainable changes can significantly impact growers, making them cautious about investing in projects with longer payback periods. There is uncertainty about the survival of their companies in the next five years, leading to hesitation in adopting new sustainable innovations with extended return rates. *"Given the current political climate, you must be certain of your existence by the time the investment pays off*" (Grower 5, Appendix 1).

Additionally, both crops and greenhouse systems require time to adapt to changes and find optimal integration of new innovations. This relates to another barrier, which is time constraints (Caldera et al., 2019; Wreford et al., 2017). The only opportunity for implementing changes is between harvest cycles, limiting the timeframe for growers and innovations to install and adapt to new greenhouse systems. *"If it takes too long, it puts the harvest at risk, and that is never acceptable"* (Grower 4, Appendix 1).

Another barrier is the lack of knowledge and skill among growers and innovations to effectively implement new technologies (Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Kuntosch et al., 2020; Moons et al., 2022; Wreford et al., 2017). Integrating new technologies into a greenhouse is a complex process. Numerous interconnected parameters need to be managed to optimize plant growth and quality. *"Just a few LED lights can alter the temperature profile, growth, humidity, and more"* (Grower 5, Appendix 1). This means that both entrepreneurs and growers need to understand the effects of new innovations on cultivation methods. Developing protocols without large-scale testing can result in a negative feedback loop. *"It's better to observe how others perceive the product and incorporate it into their cultivation methods"* (Grower 6). Sustainable startups should pay particular attention to this aspect and provide growers with guidelines to facilitate the integration of their innovations into greenhouse systems. This is currently a focus for case study 2, FOTONIQ.

Both experts and entrepreneurs have described greenhouse growers as risk-averse (Caldera et al., 2019; Moons et al., 2022). While growers can adapt quickly in times of crisis, they tend to be more cautious during stable periods (Expert 4, Appendix 1). Entrepreneurs have encountered situations where growers are willing to test new prototypes but are reluctant to face associated risks. The term "conservative" is often used to characterize Dutch growers. This risk aversion barrier is significantly influenced by another barrier, which is competing pressure(Farhangi et al., 2020; Kishna et al., 2011; Wreford et al., 2017). Currently, growers are facing considerable stress, both financially and politically. A Dutch financial newspaper reported in 2022 that approximately 40% of growers are at risk of bankruptcy (van der Boon, 2022). This situation hampers the diffusion of new products, as growers are less likely to demonstrate results for large-scale greenhouses and are hesitant to take financial risks. Expert 3 summarized both barriers by stating, *"It's difficult for startups to test their products on such a large greenhouse to gather enough evidence of success. Growers don't want to have other experiment with their greenhouses or crops, but also will not take any innovations which aren't field tested. This is a difficult loop to break sometimes"* (Expert 3, Appendix 1).

Sectoral

The sectoral barriers within the Dhc sector also contribute to the barriers to sustainable innovations. One important factor to highlight is the growers' limited power in the supply chain, which has been consistently identified in various studies (Kishna et al., 2011; Melorose et al., 2015; Moons et al., 2022). Large retail corporations have the ability to pit growers against each other, competing for the lowest prices for their products (Kishna et al., 2017; Moons et al., 2022). This reduces growers' capacity to increase prices for products produced using more sustainable methods or of higher quality. Moreover, since consumers and suppliers are not in direct contact, differentiation based on product quality or lower carbon footprint is not feasible. As Grower 6 expressed, "*You can't allow your operational expenses to increase too much, otherwise your prices will rise, and you'll lose sales"* (Appendix 1). This discourages growers from investing in expensive sustainable methods, as they are not the primary beneficiaries of innovations that only impact the sustainability of their production process. Grower 2 added, *"Even if your plants have higher quality, you won't get any added value. You'll only be sure you can sell them" (*Appendix 1). Growers' associations are attempting to shift the power dynamics in the supply chain away from large retail corporations, but this process takes time and requires growers to join such associations (Kishna et al., 2017; Melorose et al., 2015).

Consumer behavior also acts as a barrier to growers adopting sustainable innovations (Kishna et al., 2017; Melorose et al., 2015; Moons et al., 2022). While there is a recent trend of consumers purchasing more sustainable products (see section 5.1.6), growers do not currently derive significant benefits from implementing sustainable innovations or practices. Expert 4 echoed this sentiment, noting that consumers have been conditioned for generations to prioritize the cheapest option rather than products made using the most sustainable methods. *"It will take a long time and numerous marketing campaigns to*

change their views and priorities when shopping," stated Expert 4 (Appendix 1). Furthermore, consumer demand for off-season foods continues to drive growers to produce crops during the winter season, despite the higher emissions resulting from necessary heating. This issue will be further explored in the next section, as it is also connected to current governmental policies.

The size of the greenhouses poses another sectoral barrier for startups. As greenhouses become larger, it becomes more costly to produce enough prototypes for testing their effectiveness on the scale of a functional greenhouse. Startups often bear these costs, as growers are unwilling to take financial risks and provide locations for testing (Expert 3, Entrepreneur 2, Appendix 1). Entrepreneur 2 highlighted how the results from a 500m2 demo greenhouse cannot be compared to a 4ha greenhouse. Expert 3 emphasized the difficulty startups face in testing their products on such a large scale to gather sufficient evidence of success (Appendix 1). Future sustainable startups should develop strategies to overcome this challenge. This study will show examples of such strategies for the case study startups.

Political barriers

Political factors also play a significant role in hindering the implementation of sustainable innovations. Firstly, the current climate policies have both positive and negative impacts on implementation. Literature has highlighted how certain policies can negatively affect the adoption of sustainable innovations (Caldera et al., 2019; Farhangi et al., 2020; Kishna et al., 2011; Moons et al., 2022; Wreford et al., 2017). (Caldera et al., 2019; Kuntosch et al., 2020; Wreford et al., 2017). For instance, regulations concerning multifunctional buildings have created barriers to the development of innovative food-producing initiatives such as circular vertical farming (Farhangi et al., 2019).

The interviews of this study revealed that some growers, who have fixed contracts for fossil fuel use, utilize Combined Heat and Power (CHP) systems to generate revenue. These systems involve burning fossil fuels to produce heat, CO2, and electricity. It serves as a powerful tool for growers to heat their greenhouses, increase CO2 levels for enhanced production, and generate electrical energy for personal use or sale. During periods of high electricity demand in the Netherlands, growers can supply the needed power through these systems. While this arrangement is advantageous for the Netherlands and the growers, those with fixed fossil fuel contracts enjoy gas consumption below market prices while profiting from electricity provision to the grid. Consequently, the CHP systems have been viewed as money-making machines due to recent inflation. Expert 3 noted*, "Some growers already know that 2024 will be the most lucrative year of their lives"* (Appendix 1). Although financially beneficial for growers, this has impeded the sector's progress in reducing its carbon footprint. Policy makers could potentially establish caps on the profits derived from supplying electricity to the grid through fossil fuel consumption practices. Sustainable startups can also utilize this opportunity by targeting the growers with fixed fossil fuel contracts, since they would have a higher budget for innovations in 2024.

Similarly, the demand for off-seasonal crops, such as cucumbers in the winter, poses a challenge. This high energy cultivations have been subject to Dutch public debate yet the

production of winter cucumbers has continued to increase in recent years (Boerenbond, 2021; van Rijswick & Gomersback, 2021). This trend is largely driven by consumer demand, which incentivizes suppliers to produce crops year-round. This cycle of production and consumption can be difficult to break, requiring action from either party or government intervention. Unfortunately, governments often hesitate to scale back national production if other countries do not follow suit, as noted by Wreford et al. (2017). Consequently, sustainable innovations that could reduce emissions but also lead to a decrease in national production within the sector are likely to encounter additional sectoral barriers. As expressed by Grower 5, "We can still make enough money using the CHP while maximizing gas consumption. But you also want to have a sense of pride when you come home. You want to have the feeling you did something right at the end of the day" (Appendix 1).

The final political barrier to sustainable innovation is political uncertainty. Although pressure for environmentally friendly practices theoretically promotes the implementation of sustainable innovations, the lack of certain environmental policies has already been identified as a barrier. However, interviews with growers suggest that certain governmental policies have actually scared them. For instance, the recent implementation of legislation concerning the Nitrogen level in farmlands has triggered a national outcry from farmers and growers. This particular action has created uncertainty about potential future policy changes. One grower even stated that *"the government changes like the weather, you can't be sure if the wind ever blows your way" (*Grower 1, Appendix 1). Growers are concerned that they will be unable to adapt to new and stringent conditions, such as the Carbon tax or other environmental policies, and have decided to reduce their investments. Another grower commented, *"If they implement the carbon taxation, I will likely be bankrupt before the payback time is over"* (Grower 5, Appendix 1). These concerns are not exclusive to growers, as experts have also expressed their opinions regarding governmental actions. In the interview with Expert 4, it was mentioned how the government is too stringent on certain policies while being too lax on others, further adding to the confusion about possible future political action.

APPENDIX 2: FEEDBACK CASE STUDIES

In this appendix, the written feedback from the case study startups is provided. This feedback is unedited from the provided text.

A2.1 FEEDBACK FROM THERMELEON

“The implementation of both the TIS Framework and SBMC provides insight into why a specific niche strategy is of importance per phase of the company. For hardware startups it is common that the engineers are tempted to make perfectly working technology without considering the market demand or are struggling with bringing the technology to market due to lack of focus on the minimum viable product (MVP). The TIS framework provided Thermeleon with information on the viability of technology in its current state, followed by a suitable niche strategy to improve its viability. The SBMC was already implemented at Thermeleon, but without the TIS framework. Via this SBMC the niche strategy is visualized, first only based on the experience of the entrepreneur. By including the input of the TIS framework the niche strategy per company phase is constructive and visualizes the underlying reason of the chosen niche strategy. As a result enabling clear communication about the company’s strategy, including how each niche strategy follows one another.”

-Liesanne Wieleman, Co-Founder Thermeleon

A2.2 FEEDBACK FROM FOTONIQ

“It seems like a great piece with a lot of text with assumptions that could have been further refined in additional sessions. I would like to suggest that if you plan to work with this framework in the future, try to create a simplified version of it that can be combined with BMC in short progress meetings. Regularly re-visiting the assumptions will help the team to continuously learn from it. Why do I say this?... It looks like you have invested a lot of time into this, and it would be a shame if it becomes outdated when you try to apply it in a real business case because too much time has passed and new insights are gained. For example, in our case much of the information and assumptions still stand, however some of the assumptions have been validated to be true/false and new ones have been formed.

Another piece of advice, specifically for this thesis project, is to add TL;DR as a summary and key takeaways of the whole piece. This way, you can provide advice to the case client in the form of bullet points and to the scientific reader in a similar fashion.”

-Bob Vonk, Business Developer FOTONIQ

APPENDIX 3: THE STN MODEL

In this appendix, the STN model will be fully explained. This will be done by describing the steps startups need to take to fill in the model. For each step, the necessary background information of the step will be provided. This appendix also explains the connection between the SBMC, TIS framework and niche strategies**.** The link to the model is provided in the supporting documents, Appendix 5.

STEP 1: FILL IN THE SBMC

The first step of the STN model is to fill in the SBMC (Figure A3.1). Filling in the SBMC will help structure the business model of the startup. The user of the STN model can utilize the 'sticky- notes' in the Miro board, to fill in the necessary information.

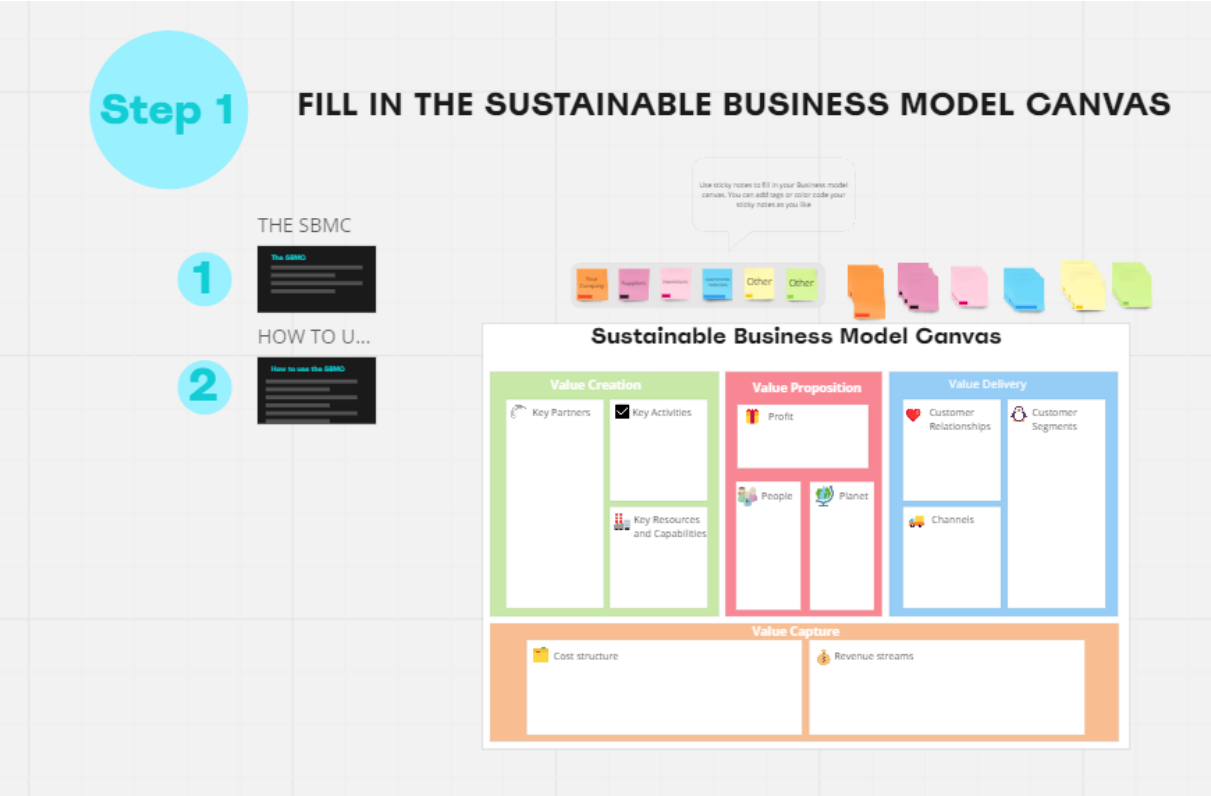

Figure A3.1 First step to the STN Model, filling in the SBMC.

STEP 2: APPLY THE TIS FRAMEWORK

Step 2 of the STN model involves applying the TIS framework (Figure A3.2). To achieve this, the startup should begin by assessing the status of their TIS building blocks. Chapters 7.2.1 and 8.2.1 can serve as a useful example for how to apply the TIS framework to the startup. Once the status of the TIS building blocks has been determined, the startup should identify the status of the TIS influencing factors and determine which TIS building blocks are affected by these factors. This can be done by using arrows to connect hindering influencing factors to incompatible TIS building blocks. The startup should ensure that all lacking TIS building blocks are linked to hindering influencing factors. This process can provide the startup with a better understanding of their TIS strengths and

weaknesses, and enable them to make informed decisions on how to improve and optimize their operations.

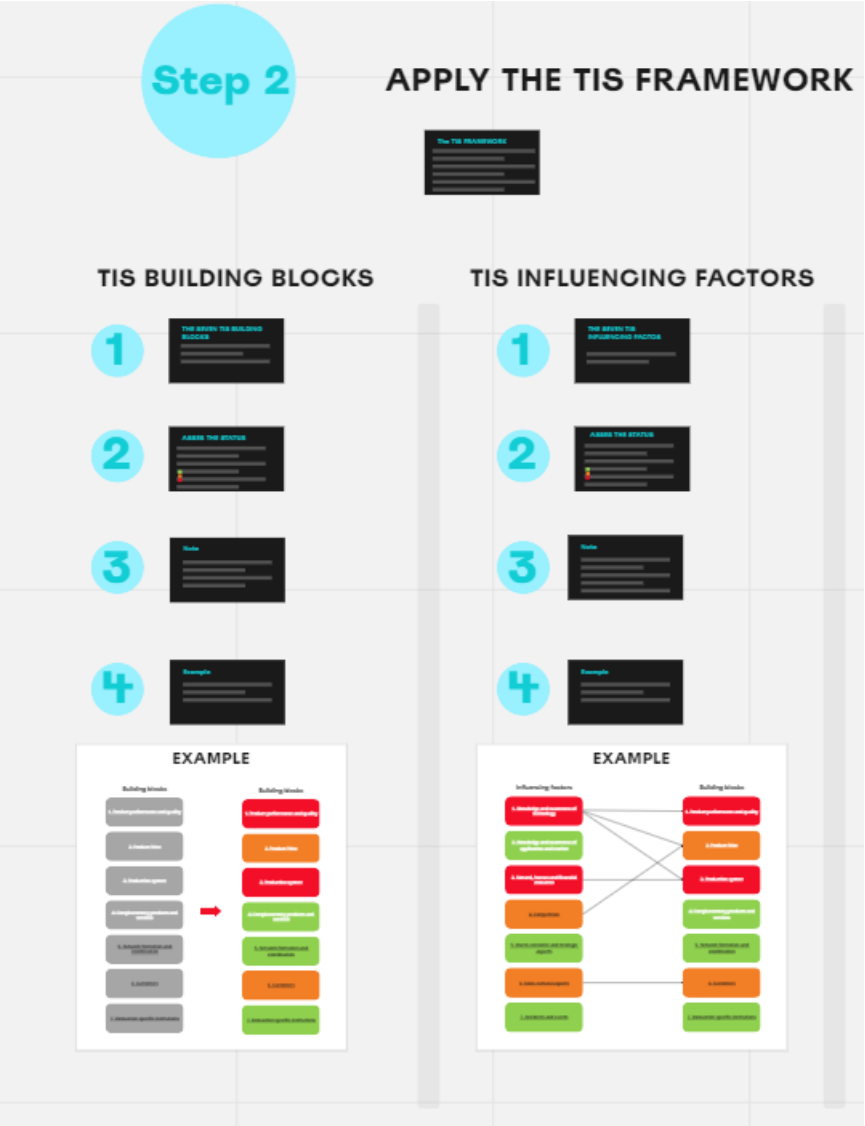

Figure A3.2 STN model step 2; Apply the TIS framework

In the final part of Step 2, the startup should determine how the TIS building blocks that are incomplete or incompatible are connected to the SBMC. This step can be helpful in validating the startup's business models. By identifying the TIS building block that is incompatible or incomplete, the startup can find which parts of the SBMC are similarly incompatible or incomplete. Figure A3.3 shows how each TIS building block is connected to each SBMC part. The two parts of the figure are enhanced and displayed in figures A3.4 and A3.5. The startups should use colored arrows, similar to the example in the figure, to indicate the status of the TIS building blocks. This way, the startup can see what parts of the SBMC can similarly be incomplete or incompatible. It is important to note that not all the SBMC parts that an incomplete TIS building block is connected to, are similarly incomplete. The connection is mean to help highlight what parts of the SBMC *might* be incomplete. The startup should see for themselves what parts of the SBMC are not ready

for large-scale production, and set those as targets for improvement. These targets will be the focus of Step 3 of the STN model.

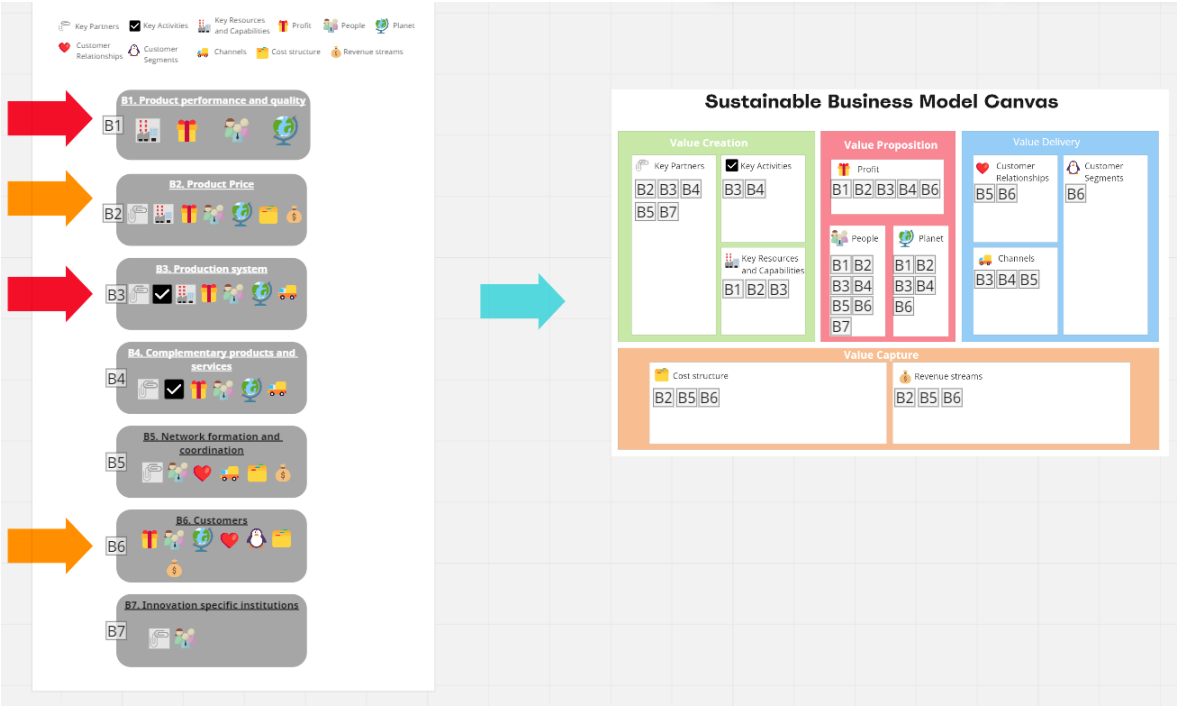

Figure A3.3 Connection between the TIS building blocks and the SBMC

On the left hand side, the icons representing the 11 SBMC parts are placed in the TIS building blocks to show the connection. On the right hand side, the seven building blocks are numbered and placed in the SBMC parts they are connected to. This way, the connection of the TIS building block and the SBMC parts are shown in both ways. Finally, the red and orange arrows indicate the status of the (partly) incompatible building blocks from the example as displayed in the previous figure (Figure A3.2).

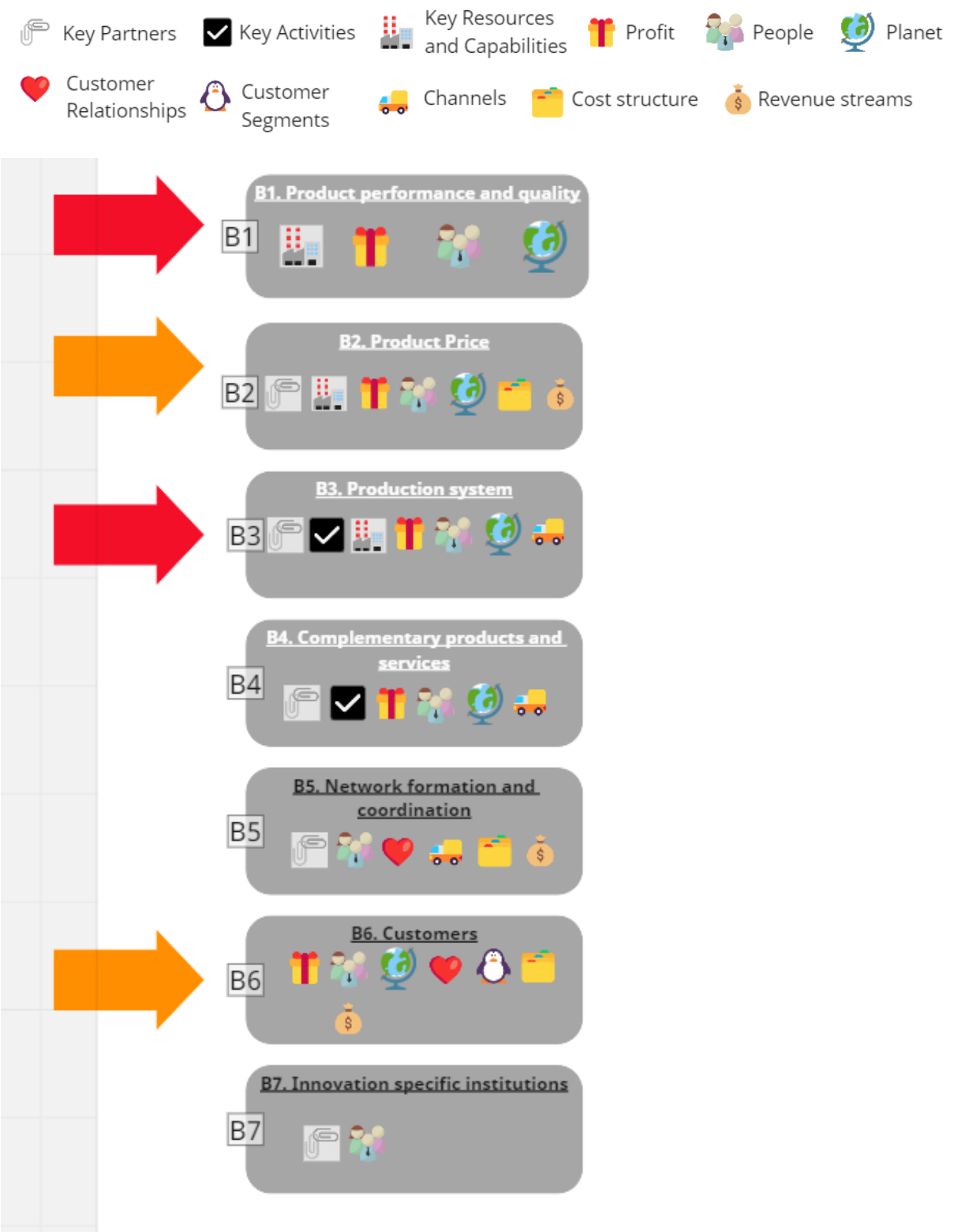

Figure A3.4 SBMC connection to the TIS building block.

At the top of the figure, the legend of the icons representing the 11 SBMC parts is shows. The SBMC parts connected each TIS building blocks is represented by the icons of each parts placed in the TIS building blocks to show the connection. The red and orange arrows indicate the status of the (partly) incompatible building blocks from the example (Figure A3.2).

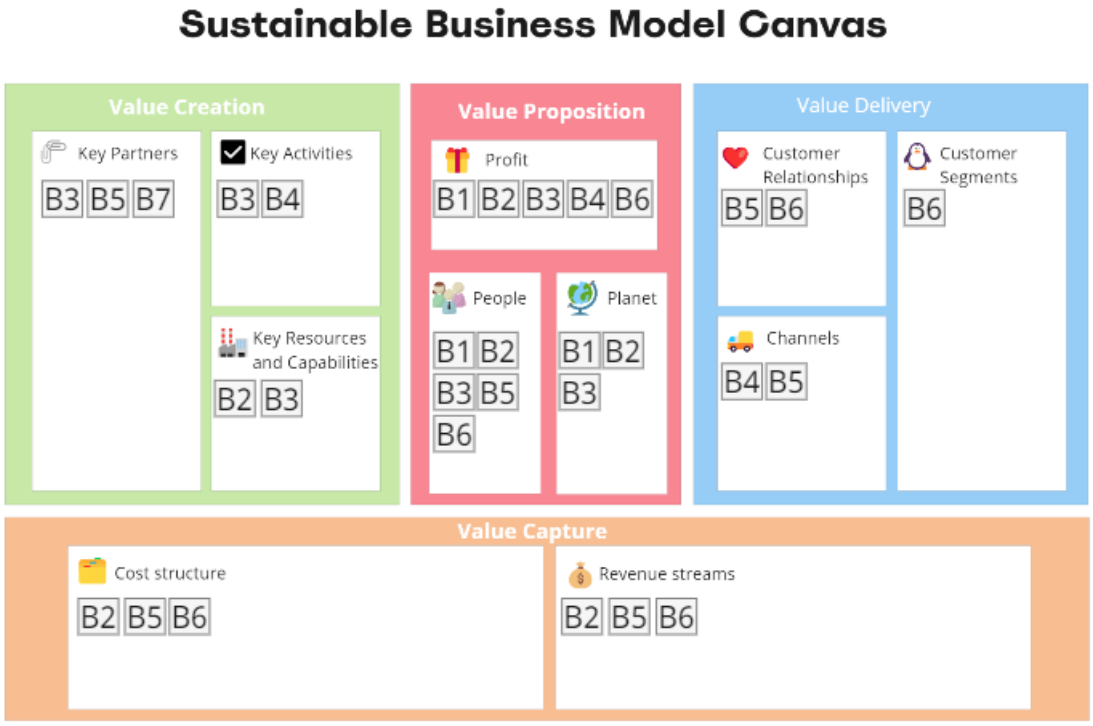

Figure A3.5 TIS building block connected to the SBMC parts.
The seven TIS building blocks are represented by number (B1-B7) and placed in the SBMC parts they are connected to.

Here, we will describe the connection of each TIS building block to the SBMC and the underlying reasoning behind it.

B1: Product Performance and Quality

This building block is connected to the Key Resources and Capabilities and the Value Proposition. If the product is not yet ready for large-scale adoption, it may indicate that the company is unable to produce the product with the required level of quality or improve its performance. While technical limitations may contribute to this issue, it could also be due to a lack of capable employees who possess the necessary expertise to enhance the product's performance.
The product is typically the central component of the Value Proposition, and any deficiency in its performance or quality can negatively impact the overall value to the customer. This can result in insufficient Profit for the Value Proposition. Furthermore, in the context of the SBMC, the Value Proposition encompasses not only value for the customer but also value for society (people) and the environment (planet). Therefore, if the sustainable innovation's performance falls short, it may result in a lack of societal or environmental impact.

B2. Product Price

If the TIS building block Product Price is acting as a barrier, there could be several reasons behind it. One possibility is that the company lacks the appropriate Key Resources and Capabilities required to produce the product with the desired Product Price. By upgrading

to higher quality resources or equipment, the company can improve the product's quality, which can lead to a reduction in its perceived price. This, in turn, can make the product more competitive and appealing to customers.
Alternatively, the issue could stem from a lack of suitable Key Partners who can provide the necessary resources at an affordable price. A poor Product Price could also indicate that the Value Proposition offered by the company is not adequate compared to the proposed price. If the Value Proposition is not high enough, the Value Proposition profit, people, and planet might suffer. In this case, the company needs to enhance the Value Proposition by improving its product or service. This can increase the perceived value of the product, making it more attractive to clients or society and even leading to subsidies that can further reduce the price.
Additionally, the Cost Structure might be a contributing factor to the undesired state of this building block. If the company is experiencing high costs for some aspects, it can translate to a higher Product Price. Alternatively, improving the Revenue Streams by changing, for example, to a rental or lease model. This could help reduce the perceived Product Price, as customers can pay rental fees instead of buying the product outright.

B3. Production System

If the Production System is not yet ready for large-scale diffusion, it may be due to a lack of Key Partners who possess the necessary expertise to alleviate bottlenecks or perform certain steps in the production process. In addition, Key Activities are closely linked to production, as the product's manufacture is a vital aspect. The production process could be either partly outsourced or internally modified to prepare it for large-scale diffusion, by improving either the Key Partner and Key Activities. Key Resources and Capabilities may also influence the Production System in various ways. The production process may be limited by inadequate resources or a lack of the right capabilities within the company to increase production levels.
Furthermore, the TIS building block's status may be affected by the Production System's profitability or its potential negative impact on society and the environment. This connection emphasizes the importance of the Value Proposition, as a lack of value for the customer, society, or the environment may negatively impact the Production System's overall profitability and sustainability.
Finally, the company's Channels may also affect the Production System's status. The logistics of acquiring raw materials or distributing the finished product is critical to the Production System's capabilities, and any shortcomings in this area could hinder the Production System.

B4. Complementary products and services

The success of this building block depends on having the right Key Partners. These partners are often responsible for providing complementary products or services that enhance the value of the main product. For example, in the case of FOTONIQ's PAR+ coating, other companies may provide installation or application services. A lack of this building block could indicate a shortage of suitable Key Partners who can provide the necessary services. In this case, the company may need to consider incorporating these Key Activities into their own business model or find new Key Partners who can offer these services. However, it is important to note that the company should still focus on its core

business and outsource non-core activities to maintain profitability. To achieve this, effective Channel management is crucial to maintain profitable business relationships with Key Partners.
Complementary products and services are essential for enhancing the Value Proposition (profit) for customers and are crucial for the societal and environmental values as well. For instance, if the company's product needs special waste treatment methods at the end of its life, the lack of a proper waste disposal partner can negatively impact the company's Value Proposition for the environment (Planet) and society (People).

B5. Network formation and coordination
This building block is crucial to the success of a company, as it involves the formation and management of networks necessary for the innovation's production, supply, and distribution. Key Partners play a significant role in establishing and maintaining these networks, while Customer Relations can influence the adoption and distribution of the product. Channels are equally important as they facilitate connections between different actors involved in the process. A poorly functioning network can negatively impact the Cost Structure and Revenue streams. Startups need to focus on managing and improving their networks to avoid costly disruptions and ensure the smooth flow of revenue.

B6. Customers
If this building block is not functioning well, it could result in a failing Value Proposition for the Customers. The perceived value might not be high enough to justify the cost of integrating the innovation into their practices. Startups can add Key Activities to help customers integrate their products more easily. Weak Customer Relations or not targeting the right Customer Segments can also lead to the failing of this building block. Startups could analyze their Cost Structure to reduce prices for the customers or explore alternative models of Revenue Streams to improve the perceived value.

B7. Innovation-specific institutions
This building block outlines the formal and informal rules and regulations that impact the company. With the right Key Partners, startups can lobby against or circumvent regulations if their innovation has a significant value for society. Hence, the Value Proposition People should be high for society, and the company needs to have strong ties with Key Partners who have political aspirations.

STEP 3: FIND A NICHE STRATEGY

The third step in the STN model is to identify a suitable niche strategy for the startup. This can be achieved by referring to the table in figure A3.6 (see also Table 3.1 in Chapter 3), which provides niche strategies based on the current status of the TIS framework. The startup should focus on implementing strategies that target the main hindering factors of the TIS framework, similar to the approach taken in case study startups in Chapters 6 and 7.

Once the niche strategy is identified, the STN model provides a template in Figure A3.7 for creating a timeline for its implementation. The startup can use this template to determine

when to implement the niche strategy and prepare for potential positive or negative cases. To prepare for potential outcomes, the startup can brainstorm and identify additional strategies that can be implemented in either scenario. By doing so, the startup can proactively mitigate risks and increase its chances of success.

It is crucial to regularly review and assess the niche strategy and timeline to ensure they remain aligned with the current status of the TIS framework and any changes in the market or industry. This adaptability enables the startup to modify and adjust its strategies to achieve its objectives effectively.

Figure A3.6 Third step to the STN Model, finding niche strategies

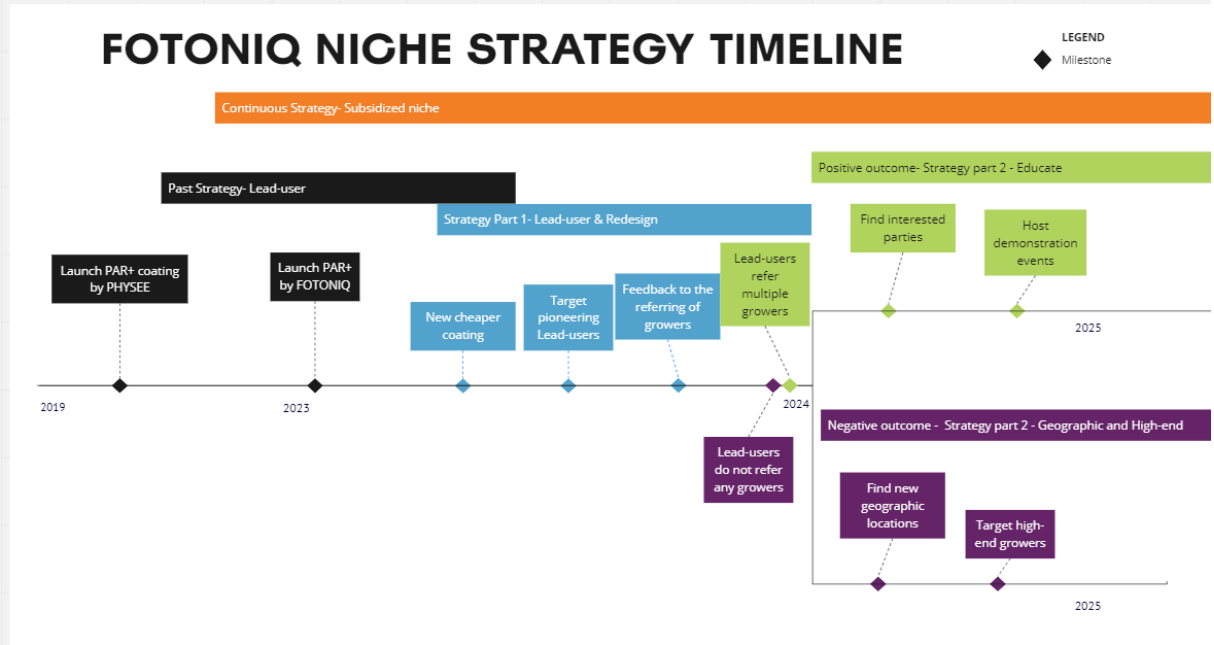

Figure A3.7 Example of a nice strategy timeline

STEP 4: IMPROVE YOUR BUSINESS

In the final step of the STN model, the startup should determine how the chosen niche strategies can help their business. This is done by connecting the niche strategies to both the TIS building blocks and the SBMC, as shown in Figure A3.8. Figure A3.9 displays how each niche strategy can affect the seven TIS building blocks. By connecting the niche strategies to the TIS building blocks, the startup can gain deeper insight into how their chosen niche strategies can improve the TIS building blocks. This provides more clarity and a clear target for the niche strategies.

Likewise, by connecting the niche strategies to the SBMC, the startup can improve the parts of the SBMC that are lacking (Figure A3.10). This incompleteness of the SBMC can be traced back to step 2, where the incomplete TIS building blocks are connected to the SBMC, highlighting what parts of the SBMC might not be complete, similar to the TIS building blocks. The connection of the SBMC to TIS building blocks and niche strategies creates clear targets for the startup to focus on to improve, as well as means to improve them through niche strategies. The specific way to implement the strategies should be made such that they target the incomplete TIS building blocks and SBMC parts, and visualized into a clear timeline.

It is important for the startup to regularly review and assess how their chosen niche strategies are impacting the TIS building blocks and the SBMC. This adaptability allows the startup to modify and adjust its strategies to achieve its objectives effectively. By doing so, the startup can increase its chances of success and achieve sustainable growth in the market or industry.

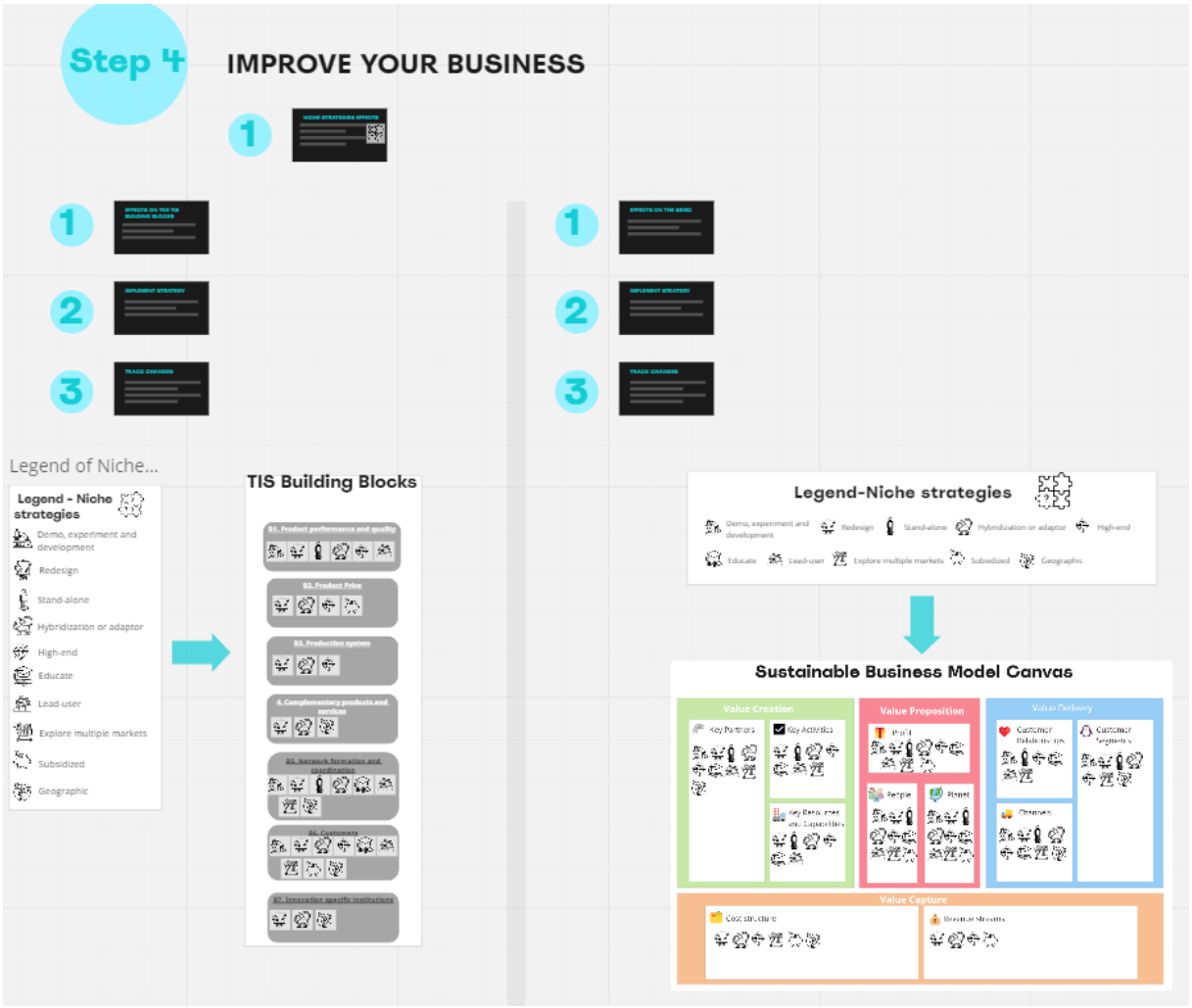

Figure A3.8 The fourth step of the STN model; improve your business

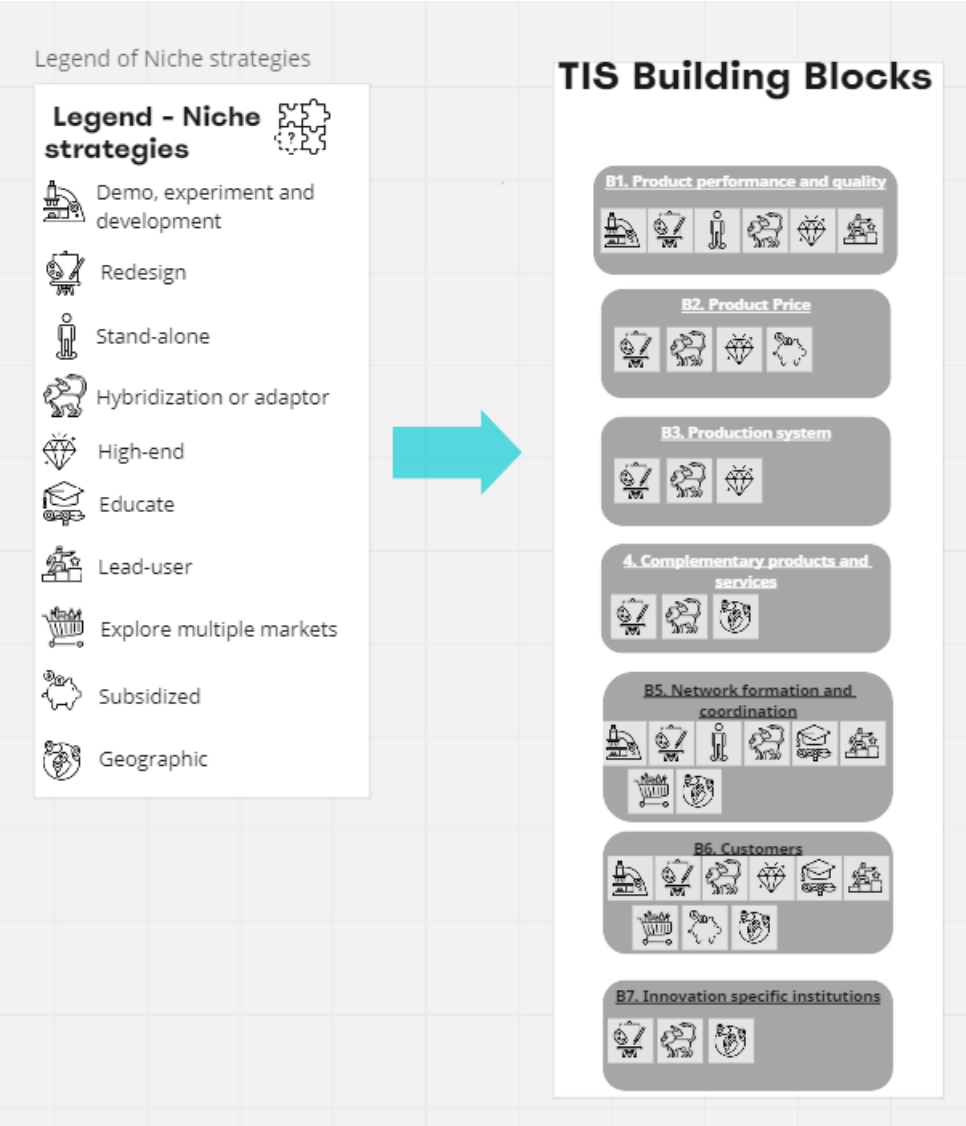

Figure A3.9 Connection of the niche strategies to the TIS building blocks

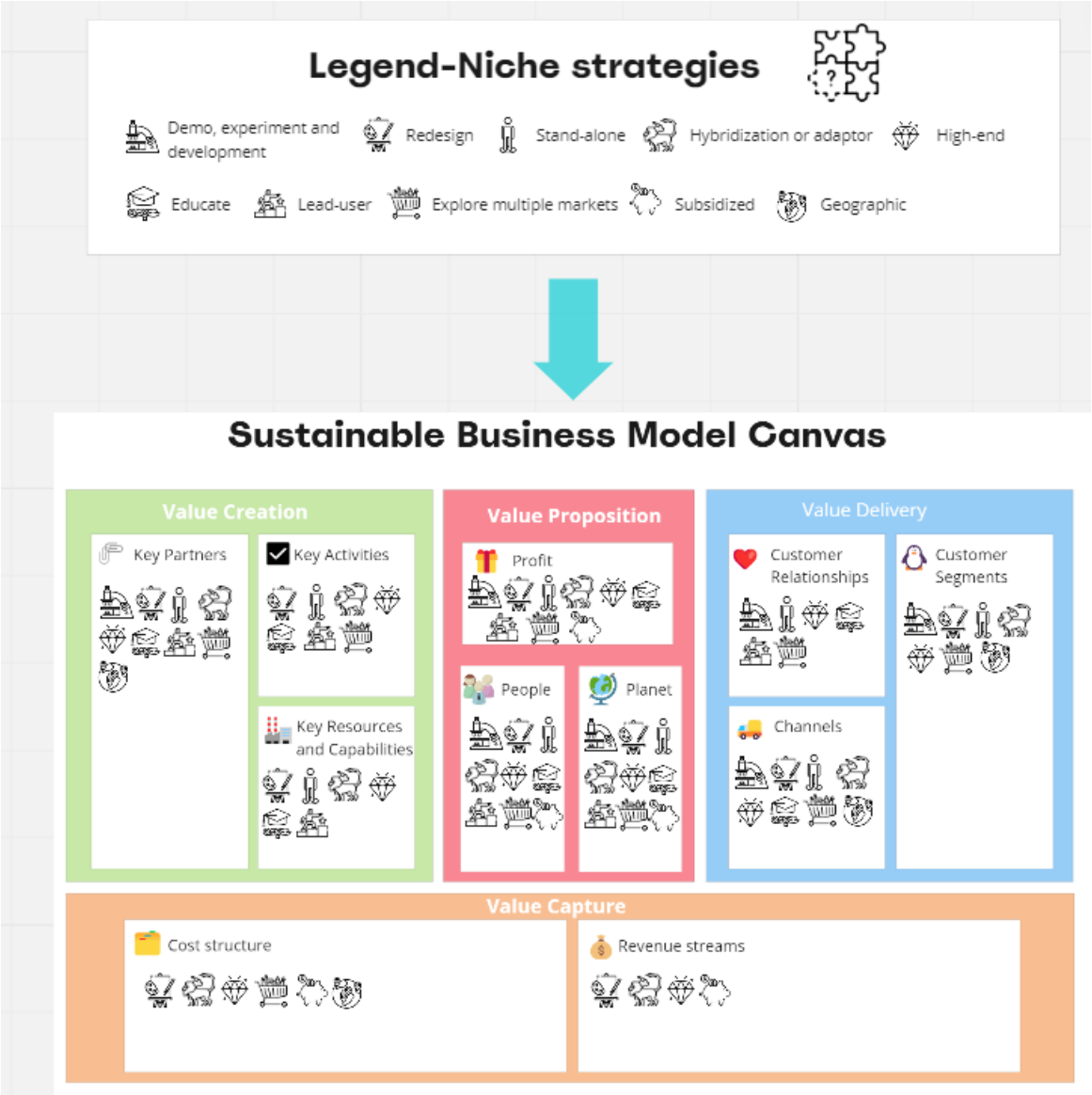

Figure A3.10 Connection of the niche strategies to the SBMC

Here, we will describe how each niche strategy can affect the TIS building blocks and SBMC parts.

<u>Demo, experiment and develop niche strategy:</u>
This first niche strategy aims to develop the product by experimentation and demonstrate the product in public in a controlled way. Implementing this strategy will enhance Product Performance and Quality (B1), and ultimately improve the startup's Value Proposition. By showcasing the product to a wider audience, the network of Key Partners can come together to witness the impact of the innovation, which can improve the TIS building block of Network formation and coordination (B5). If executed successfully, this can strengthen relationships between Key Partners and enhance coordination among stakeholders, potentially leading to new partnerships and beneficial Channels. Additionally, the startup's target Customer Segments should attend the demonstration to reinforce Customer Relations, which can improve the TIS building block of Customers (B6). Overall,

this strategy can positively impact all three TIS building blocks and seven SBMS components.

Redesign niche strategy

The Redesign niche strategy has the potential to transform nearly every aspect of the product, from its Performance and Quality (B1) to its Price (B2). Such changes may also require modifications to the Production System (B3), involving new actors and altering established Networks (B5). Furthermore, the product can be modified to better align with existing Complementary products and services (B4) and Innovation-specific institutions (B7). Finally, the product can be altered to better resonate with the targeted customers (B6). Meaning, all TIS building blocks can be affected by this niche strategy, based on the method of implementation. Similarly, Redesign may influence most components of the SBMS, with the exception of Customer Relations. Changing the product will not directly improve or change Customer Relations.

Stand-alone niche strategy

The stand-alone niche strategy involves either presenting the product as a stand-alone item or integrating it into an existing product or service. Integrating the innovation into another product or service can impact its performance and quality (B1), thereby affecting the Value Proposition. Additionally, this strategy requires new forms of networks (B5), particularly with the existing product or service the innovation will be integrated with. This shift can affect the relationships with Key Partners, as well as the Key Activities the company will need to perform to ensure the new integrated systems operate well together. Furthermore, this increases the Key Resources of the company as it can leverage the existing infrastructure of the complementary product or service. Finally, the entire value delivery will change, as the innovation will be integrated into the value delivery of the existing product or service. Therefore, the Customer Relations will be through the existing product as a medium, as well as the Customer Segments and Channels.

Hybridization or adaptor niche strategy

The hybridization or adaptor niche strategy involves combining the startup's innovation with existing products to leverage complementary products or services. This strategy can lead to product improvements, including better performance and quality (B1), and an improved Value Proposition. By combining the product with another, the startup can also benefit from existing production systems, potentially improving the Product Price (B2), Production Systems (B3) and Complementary products and services (B4) TIS building blocks.

This strategy impacts nearly every aspect of the SBMC. Changing the product influences the Value Proposition, requiring new Key Partners to integrate the innovation with the existing product. These new partners will affect and possible improve the Network coordination (B5) for company. Additionally, changes in the Production System will alter the Key Activities as well as the needed Channels (for suppliers). Key Resources and Capabilities will include those from the product the innovation will be combined with, thereby expanding this part of the SBMC. Furthermore, the new hybrid product will target other Customer Segments through different Channels, resulting in changes to the Customers (B6) as well as the Cost Structure and Revenue Streams. This strategy can also

affect the innovation-specific institutions (B7), as the startup may need to navigate intellectual property and regulatory issues related to the combination of the two products.

High-end niche strategy

The high-end niche strategy involves producing a specially made, high-end version of the product to target specific high-end customers. This approach can alter the product's quality(B1), price (B2), and Production System (B3) to target this Customer Segment (B6), resulting in a different Value Proposition and Value Capture (Cost Structure and Revenue streams). To successful implement this strategy, the products needs to be made with the highest possible quality, thus the company needs employees capable to make such a product. This means the Key Activities and Key Resources and Capabilities should be in line with this goal. Additionally, the Customer Segments will be focused on the high-end once, with which the company need close Customer Relations. To produce such a high-end product, the startup would need to have new supply Channels to get top quality resources and possible new Key Partners to obtain those.

Educate niche strategy

The Educate niche strategy presents an opportunity to enhance the knowledge and awareness of the innovation within the industry, which can have a positive impact on Network formation and coordination (B5). Moreover, it can lead to an improvement in the status of the Customer TIS block if customers are the focus of the strategy.

When it comes to the SBMC, the implementation of this strategy will require the addition of educational activities to the Key Activities of the startup. This can help establish the startup as an industry expert, which can improve their reputation and increase the potential for Key Partnerships, stronger Customer Relations, and new Channels. However, the implementation of this strategy will require additional resources for developing educational content and reaching out to potential clients or suppliers, which can also increase the Key Capabilities of the employees of the startup.

Overall, the Educate strategy can add value to the sector by providing knowledge, which can enhance the Value Proposition of the startup. Therefore, startup leaders should consider implementing this strategy as part of their business model to improve their TIS building blocks and SBMC components.

Lead user niche strategy

The lead user strategy connects a startup with its first customer to co-develop the product, thereby improving its performance and quality (B1). In addition to these benefits, the strategy can improve the Network formation and coordination (B5) of the startup due to the close relationship with the lead user and their potential connection to their network. This approach can also help the startup to better understand the needs and wants of future customers, thereby improving the Customer TIS building block (B6) .

The implementation of this strategy can lead to changes in several SBMC parts. For example, the Key Partners will likely improve due to the close relationship with the lead user and their network. The Key Activities will also shift more toward co-development as the startup works closely with the lead user. The Key Resources and Capabilities could be

impacted if the lead user provides unique capabilities that can help improve the application of the innovation to their specific needs (as is the case for Thermeleon) (as is the case for Thermeleon). However, this might not be the case for all startups. Nevertheless, for the purposes of this study, it is included. The Value Proposition will likely improve due to the development of the innovation, while the Customer Relations will benefit from the improved relationships with the lead user and their network.

Explore multiple markets niche strategy

This strategy involves taking the initial innovation and applying it to other sectors or markets to identify potential customer targets. As a result, the startup will need to adapt to the needs and preferences of different Customer Segments and enter new networks of actors and systems. Therefore, the TIS building blocks that will be affected are the Networks formation and coordination (B5) as well as the Customer block (B6).

To implement this strategy, the Key Partners will need to change, as new partnerships will be formed with businesses or organizations operating in the new markets. Additionally, the startup will need to identify and target new Customer Segments, which will require developing new Customer Relations and Channels.

By exploring multiple markets, the Value Proposition of the startup may improve as it will be able to provide the innovation to a broader range of customers. However, the implementation of this strategy may also require changes to the Key Activities and Cost Structure of the startup, as it may need to adapt its operations and processes to suit the needs of the new markets.

Subsidized niche strategy

To implement this strategy, the innovation must have a positive social and/or environmental impact. By doing so, the startup can receive subsidies that will increase its resources and reduce the Product Price (B2), making it more affordable and accessible to customers (B6). The additional resources can be used to further develop the product or increase its adoption by the market, potentially improving the startup's Value Proposition and competitive advantage. As a result, the Cost Structure and Revenue Streams will be affected due to the subsidies, while the Value Proposition can be improved due to the additional development funds received.

Geographic niche strategy

The geographic niche strategy involves changing the geographic location of the market launch or production of the startup's product, which would have an impact on all sector-specific components of the TIS building blocks. The Complementary products and services (B4) offered in the new location would be different, and the startup would need to navigate a new network of actors and target different customers. Furthermore, the startup would need to adapt to new institutions and regulations specific to the new geographic location.

Regarding the SBMC, the Key Partners and Channels would be altered as new actors become involved. If the startup enters a market in a different country, it would need to target new Customer Segments.

APPENDIX 4: DETAILED STAKEHOLDER ANALYSIS FOR THERMELEON

This appendix provides a detail description of the stakeholder analysis performed by this study.

We will describe three stakeholder categories of the Dhc sector, including supply chain stakeholders, political institutions, and innovation institutions. Supply chain stakeholders encompass companies responsible for the cultivation, production, and distribution of products in the sector. Sustainable startups could benefit from these stakeholders as potential targets for their innovations, specifically in addressing the carbon emissions of the sector, which the government aims to reduce to meet the SDG. Moreover, comprehending the production dynamics in this sector is crucial for startups intending to enter the market. The interactions or absence thereof among these stakeholder groups and individual actors could impact the implementation of innovations in the sector. These stakeholders will also be the focus of interviews conducted in this study.

Next, we will examine political institutions operating at both national and European levels. These stakeholders are responsible for legislation and funding that affects the implementation of innovation for startups. Understanding these institutions and their purpose can aid startups during product development. Finally, we will discuss stakeholders that aim to promote knowledge sharing and innovations, such as universities and research institutions. These stakeholders can be leveraged by innovators and startups to aid their businesses and facilitate the diffusion of their innovations in the market.

A4.1 SUPPLY CHAIN STAKEHOLDERS

This section provides an overview of the stakeholders involved in the supply chain of the Dhc sector. The supply chain encompasses organizations that participate in the production and sale of products, covering everything from 'seeds to plate'. We can distinguish between the supply chains for food (fruits and vegetables) and non-food (flowers, trees, and pot plants) products (see Figure 4.1). This section will describe a brief history of the sector leading to current trends and events within the Dhc sector supply chain. This will provide background information on the sector and highlighting potential targets for sustainable innovations, or potential barriers to innovation.

Historically, the Dutch horticulture market consisted of a small group of seed companies supplying a large number of growers with seeds. These growers then brought their products to auction, where food items were sold to wholesalers and retailers before reaching consumers (Breukers et al., 2008; Vijverberg et al., 2007). However, the landscape began to change in the 1980s with the rise of supermarket chains, leading to the decline of auction houses. To remain competitive, smaller auction houses merged, and growers formed grower associations to regain some influence in the production chain (Breukers et al., 2008; Vijverberg et al., 2007). Today, only a few food wholesale companies possess significant buying power, while numerous growers are compelled to compete for the lowest prices to sell their products (Franck & Nemes, 2017). In response, some companies are pursuing vertical chain integration, encompassing multiple steps in the

production process, including plant breeding, growing, and selling (Schoormans & Rabensbergen, 2022).

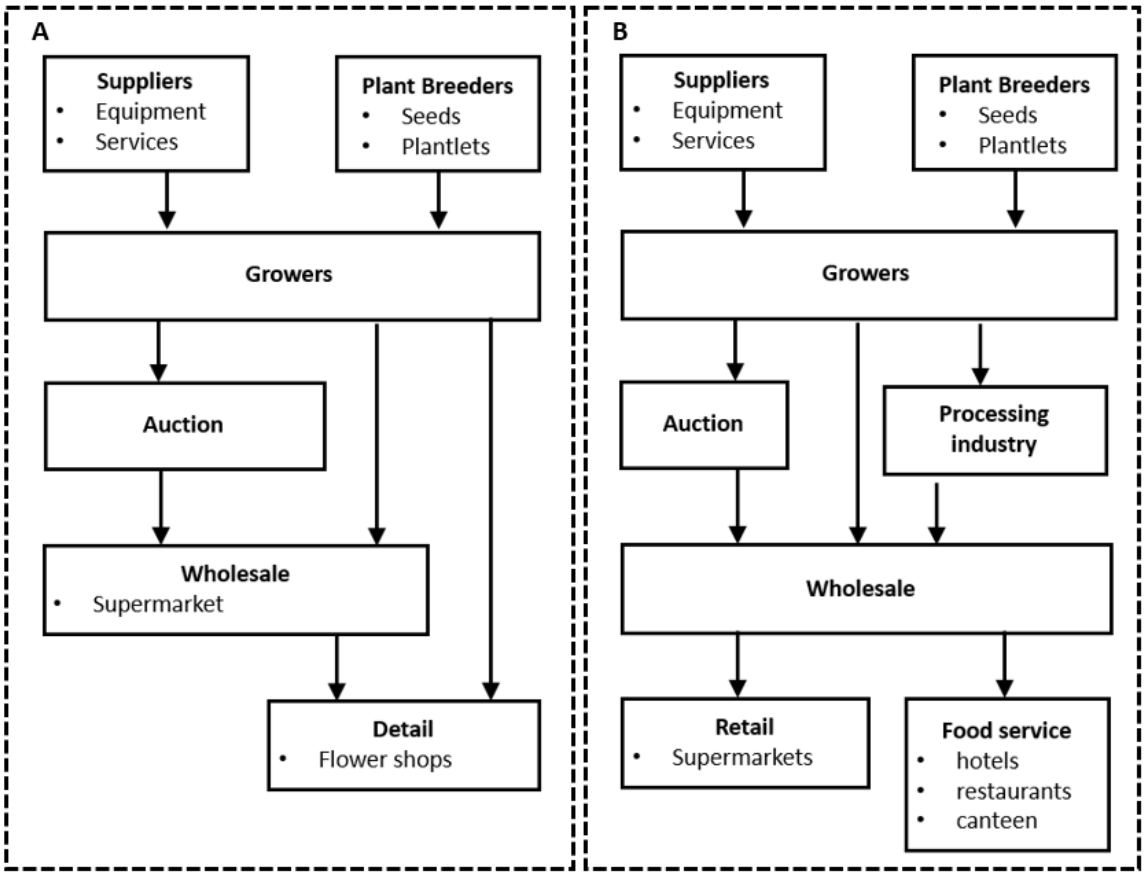

Figure A4.1 Production chain for food and non-food.
On the left (A) the production chain of non-foods is displayed in the Dutch horticulture based on (Berkhout et al., 2022). The right (B), displays the produciton chain of foods (Jukema et al., 2020).

Similarly, the Dutch flower industry has an international presence and advanced production methods(Berkhout et al., 2022). Although the rise of supermarket chains impacted the food supply chain, the flower industry in the Dutch horticultural sector remains dominated by auction houses (Schoormans & Rabensbergen, 2022; Wijnands, 2005). In fact, the Dutch auctions are the largest marketplace for flower trade globally, cementing the country's reputation as a major player in the floriculture industry. In 2020, the export value of the Dutch floriculture industry reached 9.5 billion euros (Jukema et al., 2020). Various companies in the flower industry are forming clusters to compete on an international scale (Schoormans & Rabensbergen, 2022).

Plant breeders(zaad veredeling)
Plant breeders are a vital component of the horticultural sector, focusing on producing desirable genetic strains of plants for both the food and non-food industry (Berkhout et al., 2022; Vijverberg et al., 2007). The introduction of new strains has resulted in increased yield and variety of foods produced. One such example is the mini-broccoli, a new vegetable type with reduced food wastage (SeedValley, 2021). In the Netherlands, there are only 10 plant breeding companies with over 100 employees, most of which are located

in Seed Valley, an important center for innovation and seed-related research (Berkhout et al., 2022; CBS, 2018b; SeedValley, n.d.). Seed Valley is home to the world's largest seed producers, including Rijkzwaam, Bejo, Enza Eastwest, and Syngenta Zaden. It has a significant economic and social impact, with over 50% of the world's vegetables originating from this region.

Aside from genetic practices, plant breeders also initiate the first stages of plant growth, from seed to seedling. Approximately 200 companies primarily focus on these initial growth stages, which are then sold to growers for further production (Berkhout et al., 2022). Some growers even cultivate their seedlings in separate facilities. While plant breeding companies are a small group, they supply a large number of growers, both domestically and internationally (op de Beek, 2012). As a result, plant breeding companies have healthy margins, allowing them to allocate larger budgets for innovation. This can make them a very interesting Customer Segment for sustainable startups. Sustainable startups targeting this Customer Segment should note their higher plant safety standards.

Growers

The growers are an important group of stakeholders who use seedlings provided by plant breeders to produce their products. In the Netherlands, there were 3,714 registered growers in 2021, with the total number steadily decreasing over the years due to larger companies taking over family businesses (Berkhout et al., 2022; CBS, 2022). However, the total area of greenhouses has increased.

The most commonly produced food crops in Dutch greenhouses are tomatoes, peppers, cucumbers, blackberries, and raspberries (Berkhout et al., 2022; CBS, 2022). The production of tomatoes have a particular significance with large-scale producers such as Agrocare and Combivliet with more than 100 hectares of greenhouse space, contributing to the Netherlands being the world's top producer of tomatoes per surface area (Atlas Big, 2022; Berkhout et al., 2022). The total export value of the foods produced in the Netherlands was 7 billion euros in 2020 (Berkhout et al., 2022; Jukema et al., 2020).

On the non-food side of the Dhc sector, a significant number of companies produce cut flowers, indoor plants, and garden plants. According to the Central Bureau of Statistics (CBS, 2023), the most commonly grown cut flowers in the Dhc sector are chrysanthemums, roses, gerbera, lilies, and tulips. However, the flower culture has faced a difficult period, from 2009 to around 2015 (Berkhout et al., 2022). In this period the Dhc sector experience a significant drop in floriculture growers due to as economic conditions, takeovers, no successors, limited expansion opportunities, and buyouts for housing projects. Many rose growers have been forced to stop due to international competition, from countries such as Kenya, Ethiopia, and Uganda.

The growers of both food and non-food products in the Dhc sector operate in a highly competitive and dynamic market (Berkhout et al., 2022; Jukema et al., 2020). Despite the challenges, the Netherlands remains a significant producer of high-quality products for domestic consumption and export. However, the high production values of growers are also associated with high fossil fuel consumption. The Dhc sector is responsible for 9% of

the total amount of fossil fuels consumed in the Netherlands (Van der Velden & Smit, 2020). With the current political focus on sustainability, this needs to be reduced.

The growers present an opportunity for sustainable startups due to various subsidies and incentives aimed at promoting sustainable innovations. The flower industry is facing social pressure to reduce its reliance on fossil fuels, providing a fertile ground for sustainable startups.

Trade

After the growers harvest their products, it is time for the next step in the value chain, trade. The destination of the products depends on whether they are food or non-food (Kamphuis, 2005; Menkveld & De Ruyter, 2020; Vijverberg et al., 2007). Food producers sell their products to either trade institutions or food processing companies, while non-food products go through trade companies. The size and sales method of trade institutions vary depending on the product type, and the variety of sales also depends on whether the products are exported or imported. For the purpose of this report, only products produced in the Dutch horticulture and sold in the Netherlands will be considered. For the purpose of this report, we will discuss the three main methods growers typically to sell their products within the Netherlands: auction houses, growers associations, and wholesalers (Berkhout et al., 2022).

Auction houses

In the past century, auction houses were the main trading platform for both food and non-food production in the Dutch horticulture sector (Menkveld & De Ruyter, 2020; Vijverberg et al., 2007). However, this trend has evolved over time. Although fruits are still predominantly sold through auction houses, with Fruitmaster and Zaltbommel being the leading players (Berkhout et al., 2022). The leading auction houses for vegetables is ZON (Berkhout et al., 2022).

Auction houses offer a range of services to growers beyond just the sale of products. These services may include sorting and preserving produce, among others. These auction houses also serve as a hub for the export of Dutch products to other countries. The flower industry in particular is dominated by the renowned Dutch auction house, Royal FloraHolland. With an annual turnover of over 90% of the plants and cut flowers, Royal FloraHolland is one of the largest flower auction houses in the world (Jukema et al., 2020; Menkveld & De Ruyter, 2020). As of the end of 2020, the organization had approximately 455 growers under its umbrella (Berkhout et al., 2022).

Growers associations

Growers associations are another important means of trade for food-producing growers. There are two types of growers associations: market-oriented and growers interest growers associations (Berkhout et al., 2022). The former helps growers by providing transparency in their production chain segments, shared investments in marketing concepts, and market insight, while the latter aims to improve negotiating positions, buying power of the grower, and provide size and scale benefits through joint operations such as sorting, packing, and transport. The Greenery, Qxin Growers, and Harvest House

are some of the largest growers associations in the Netherlands (Berkhout et al., 2022).. The Greenery is the largest food provider in the Netherlands, born from merging nine auctions and trading companies (Breukers et al., 2008; op de Beek, 2012). The company sells its products through long-term relationships and delivers according to client requirements. The Greenery and ZON are responsible for the majority of Dutch horticulture vegetables sold. Growers associations also play a very important role in the financing of greenhouse investments and sustainable production methods. An example of this was the additional 73 million euros was paid to the Netherlands through European subsidies due to Dutch growers associations in 2005 (Breukers et al., 2008).

Wholesale and trade companies
Finally, there are trade companies and wholesalers. For the food trade, there are some important distinctions to be made for the food wholesale companies. The larger market-oriented growers association such as The Greenery also function as wholesale companies. Aside from those, there are some large wholesale firms that supply most of the food retail such as Bakker Barendracht, Haluco Frankort & Koning, and Vers Direct Nederland (VDN) (Berkhout et al., 2022; Breukers et al., 2008). These wholesale companies are the suppliers to the Dtuch supermarket chains, such as Albert Heijn for which Bakker Barendracht is the main supplier. Aside from wholesale, food is also traded by trading companies. In the Netherlands there were 1.315 of such companies in 2019 (Berkhout et al., 2022). Much like for the growers, the number of trade companies is decreasing as larger companies take over smaller ones (CBS, Wageningen Economic Research) (Berkhout et al., 2022). These firms are relatively small overall, around 700 of them under sole proprietorship, and the other 425 companies have less than 10 employees (Berkhout et al., 2022).

For flower trade, there were around 2,495 trade companies, of which 1,200 were sole proprietorships, 800 had less than 5 employees, and 400 had no more than 20 employees (Berkhout et al., 2022). These companies differ from food trading companies in their means of trade. There are multiple types of flower trading companies, such as the 'Lineriders', that travel to flower shops to sell their flowers and plants (Berkhout et al., 2022). One of the larger trade corporations and flower traders in the world, is the Dutch Flower Group with an annual turnover of around 1.7 billion euros worldwide (Hortipoint.nl, 2020).

<u>Food processing</u>
Products from food producing growers can be sold to the food processing industry. This industry creates allot of value, increasing the types of food products that are available to the consumer. Famous Dutch food processing companies include Heinz, Danone, and Friesland Campina (BoldData, 2023). However, when it comes to horticultural products, the market share of the food processing industry is relatively small (Schout & Harkema, 2012). Processed meats and dairy products are mainly derived from agriculture and cattle farms. After processing, these products are sold to retail companies such as supermarkets or food service providers like restaurants.

However, there is a growing interest among leading brands such as Unilever and Ahold to shift towards sustainable practices (Jukema et al., 2020). Unilever, for example, has

committed to its Sustainable Living Plan, which aims to reduce the environmental footprint from the production side (Unilever, 2021). Ahold Delhaize, the parent company of supermarket giant Albert Heijn, is also actively pursuing initiatives to reduce food waste and implement environmentally-friendly packaging ((Plastic Soup Foundation, 2022). This trend highlights the increasing importance of sustainability in the food processing industry, which sustainable startups might make use of.

Retail

The next step in the chain is retail, where products from the Dhc sector industry and food processing industry are sold to end consumers through various Channels, including supermarkets, vegetable shops, flower shops, markets, and grocery stores. However, food service companies such as restaurants and catering companies are excluded from this report.

Supermarkets

Supermarkets are the main player in the food retail industry, accounting for the largest market share of fruits and vegetables sold. According to Berkhout et al., (2022), around 75% of fruits and vegetables are consumed at home, with most of them being bought through supermarkets. While webservices, fruit shops, and vegetable shops have a lower market share, they still contribute to that 75%. The remaining 25% of fruits and vegetables consumed are sold through food service companies (Berkhout et al., 2022).

In the Netherlands, the supermarket industry is a vital part of Dutch culture, with over 20% of Dutch citizens visiting supermarkets daily (CDL, 2023; Willoughby & Gore, 2018). There are over 4.3 thousand supermarkets in the country, but most are owned by 14 supermarket chains. The two largest supermarket chains hold over 50% market share, Albert Heijn 35.3% and Jumbo 18.7% (Franck & Nemes, 2017). Supermarkets sell 51% of all food and drinks consumed in the Netherlands and generally have a good reputation among Dutch consumers (Franck & Nemes, 2017; Onwezen et al., 2016)**.**

However, this sentiment is not shared by growers and other suppliers who accuse Dutch supermarkets of engaging in "criminal behavior" (Geluk & Verbeek., 2016). According to Volkert Engelsman, CEO of one of the largest suppliers of Dutch fruits and vegetables, Dutch supermarkets play their suppliers against each other in a "race to the bottom." This was confirmed by Ekoplaza's executive director, who stated that in times of plenty, retailers compete to offer the lowest price, resulting in a 'race to the bottom' for the suppliers(Vogel, 2017). Oxfam international highlighted how supermarkets take around 43.8% of the margins of the products sold, while growers take only 7.8% (Franck & Nemes, 2017; Willoughby & Gore, 2018). This power dynamic between growers and supermarkets will be further discussed in Chapter 5.

Flower shops

Next are the flower retail shops. While flowers are also sold in supermarkets, the majority of flowers are sold in flower shops (Berkhout et al., 2022; Ossevoort et al., 2012). The number of flower shops has decreased in the Netherlands, from 3.600 in 2017 to 3.135 in 2019 (Jukema et al., 2020). Flowers are also sold on by means of itinerant trade, such as markets. The market share of flower shops does not seem to diminish overtime as flower

shops have means to distinguish themselves well from supermarket chains, especially for bouquets for special occasions such as marriage or mourning.

Aside from flower shops, garden stores are also very popular for the Dutch consumer. Most pot plants are sold in these shops, as garden shops take in around 30% market share. Supermarkets and flower shops take both 20% and around 12% of the pot plants are sold online (Berkhout et al., 2022).

Consumers

The final stakeholder of the production chain is consumer, who has increasingly become aware of their role in promoting sustainable production. As a result, consumer behavior has shifted towards the consumption of meat-replacing products, fruits, and vegetables (NAGF, 2019; NOS, 2019). The National Action Plan for Vegetables and Fruit (NAGF) has even stated that they found means to promote the consumption of fruits and vegetables amongst consumers through subtitle nudges. (NAGF, 2019).
Consumers have also become more conscious of sustainability labels on products, leading to an increase in consumption of sustainable foods from 8% in 2013 to 19% in 2021 (Logatcheva, 2022). This rise in market share also extends to labels such as *"Rainforest Alliance"* and *"On the way to Planet Proof"*. Sustainable startups should take note of this trend and consider collaborating with these brands to incentivize growers to adopt more sustainable production methods. This would increase the market positioning of sustainable products and motivate growers to adopt more sustainable innovations.

A4.2 POLITICAL INSTITUTIONS

Unsurprisingly, numerous political parties are heavily involved in the sustainable transition of such an economically important sector as the Dhc sector. The political influences on the Dhc sector not only originate from a national level, but also from a European level. In this section, we will discuss some of the political institutions and initiatives that sustainable startups can utilize to promote their sustainable innovations in the Dhc sector.

Europe

The European Union provides several initiatives for businesses and startups, including Horizon Europe, The Green Deal, European Innovation Council (EIC), and the SME strategy (European Commission, 2023b). Horizon Europe (2021-2027) is the EU's main program that funds research and innovation with a budget of €95.5 billion (European Commission, 2021). The program's aim is to achieve the UN's SDG and boost sustainable innovative growth in Europe, with 70% of the budget dedicated to SMEs, which ties into the SME strategy.

With the European Green Deal, the European commission has committed to reducing greenhouse emissions. The goal is to be carbon neutral by 2050 and reduce 55% of the emissions by 2030 compared to 1990 (European Commission, 2023a). The initiative includes investments in environmentally friendly technology, helping businesses innovate, providing cleaner, cheaper, and healthier forms of transportation, decarbonizing the energy sector, and increasing the energy efficiency of buildings.

The European Innovation Council (EIC) is an initiative which aims at identifying, developing, and scaling up breakthrough technologies and game-changing innovations (European Innovation Council, 2023). It is designed to support Europe's most innovative companies and entrepreneurs by providing them with the necessary resources to turn their ideas into successful businesses.

Finally, with the SME strategy, the European Commission wishes to support and empower SMEs especially, from innovative startups to traditional craft businesses. The European commission feels that targeting SMEs is key to achieve their sustainable ambitions as SMEs are responsible for 99% of the businesses (European Commission, 2023b). This explains why many programs have a specific part of their budget set aside for SME's.

The European commission also has other financial programs for research and innovation. The ones who could be utilized by sustainable startups targeting horticulture will be described below. It should be noted, that some specific SBMs of startups aiding the Dhc sector could potentially fall under the other European funded programs such as Digital. This will of course, vary on a case-by-case basis.

LIFE is the European Union's financial instrument for environmental protection. The program aims to contribute to better European nature, environment, and climate policies. It provides funding for innovative projects that promote resource efficiency, biodiversity conservation, and awareness-raising and dissemination of information. Next is EIC Accelerator, which provides financial support to European "top SMEs" with market-oriented innovations and high growth potential through a grant or blended finance. When the grant is awarded, coaching, advice, and network expansion through matchmaking events are also provided. Finally, the Innovation Fund is a European financing fund that aims to subsidize demonstration projects that bring industrial solutions to the market to help Europe become carbon-neutral.

National

Describing all the stakeholders acting on national level in the Dutch horticultural sector is both difficult and confusing. The organizations or initiatives connect to a multitude of others for multiple reasons. This study will try to explain the dynamics of all these institutions using three main stakeholder groups who are together responsible for the enactment of sustainable transition and innovation in the Dhc sector, which are; Dutch government, Glastuinbouw Nederland, and Greenports Nederland (Glastuinbouw Nederland, 2023b; Greenports Nederland, 2023; Rijksoverheid, 2022b). In short summary the Dutch government provides policies and subsidies for sustainable transition (Rijksoverheid, 2022b). Glastuinbouw Nederland supports the companies in the Dhc sector through lobbying on all levels of governance, and the promotion of knowledge sharing through programs and other initiatives. They receive financial support from the government. Finally, Greenport Nederland is the overacting network organization combining the regional Greenports, and regional knowledge institutions.

Dutch government and policies

The Dutch government expresses their intend for sustainable transition on both national and regional levels which are recorded in four documents: the Meerjarenafspraak Energietransitie Glastuinbouw 2020, Convenant Energietransitie Glastuinbouw 2022-2030, the Tuinbouwakkoord/Tuinbouwagenda 2019-2030, and the Klimaatakkoord (28 June 2019) (Wisse & Klein, 2020; Rijksoverheid, 2022b).
The Meerjarenafspraak Energietransitie Glastuinbouw 2020 (Multi-year Agreement on Energy Transition in Greenhouse Horticulture 2020): This agreement was signed in 2012 between the Dutch government and the greenhouse horticulture sector. Its goal is to reduce greenhouse gas emissions by 25% by 2020 compared to 1990 levels. It includes measures such as improving energy efficiency, increasing the use of sustainable energy sources, and reducing the use of fossil fuels (Wisse & Klein, 2020).

However, as it was outdated, it has been replaced by a new agreement called; Convenant Energietransitie Glastuinbouw 2022-2030" signed by the Dutch ministries of Agriculture, Economic Affairs and Climate, and Finance (Rijksoverheid, 2022b). The covenant is based on a residual emissions target for greenhouse horticulture in 2030, which indicates the maximum amount of emissions this sector may still emit. This has been provisionally set at 4.3 to 4.8 Mton CO2 equivalents. The goal is for a greater reduction of 1.0 to 0.5 Mton, making it more ambitious than previous agreements, such as those in the coalition agreement. The final residual emissions target will be determined in the spring of 2023, when a number of missing measures have been developed.
The covenant contains measures and the commitment of the parties to achieve the desired goal. This is done through incentivizing measures such as subsidies, infrastructure, area-specific approach through the Greenports, the "Kas als Energiebron" program for R&D and knowledge exchange, and through measures such as further pricing of CO2 emissions through adjustment of the energy tax, improving the CO2 sector system after 2024 with an individual incentive, and mandating energy-saving measures that can be recouped within five years.
Next is the Tuinbouwakkoord/Tuinbouwagenda 2019-2030 (Horticulture Agreement/Horticulture Agenda 2019-2030): This agreement was signed in 2019 by the Dutch government and various horticulture sectors, including greenhouse horticulture. Its goal is to increase sustainability, innovation, and competitiveness in the horticulture sector. Specific measures for greenhouse horticulture include reducing the use of pesticides, improving water management, and increasing the use of renewable energy.
Finally, the Klimaatakkoord (Climate Agreement): This agreement was signed in 2019 between the Dutch government and various sectors, including greenhouse horticulture. Its goal is to reduce greenhouse gas emissions by 49% by 2030 compared to 1990 levels. Measures for greenhouse horticulture include increasing the use of geothermal energy, reducing emissions from heating systems, and improving energy efficiency.

Glastuinbouw Nederland and knowledge sharing
Glastuinbouw Nederland is an organization that initiates, stimulates, and facilitates collective knowledge development and exchange to improve the operations of its members. They do this through the active guidance of over 25 crop committees, 13 crop cooperatives, 14 horticulture regions, and 10 business groups, in partnership with

entrepreneurs, suppliers, research institutions, chain organizations, and Greenports. Together, it represents over 75% of the Dutch horticultural sector.
Their main activities include lobbying towards national, provincial, and regional governments, driving knowledge development, and inspiring entrepreneurs through knowledge exchange. They promote innovation through the innovation program "Kennis in je Kas" (KijK), which includes initiatives such as "Kas als Energiebron", "Glastuinbouw Waterproof", and "Het Nieuwe Doen in Plantgezondheid", and encourage the professionalization and renewal of horticulture companies. Finally, Glastuinbouw Nederland is the initiator of the “Stichting Innovatie Glastuinbouw” (SIGN), which works on providing sustainable technological innovations (Glastuinbouw Nederland, 2023b).

Greenports Nederland
Greenport Netherlands is a national network of regional Greenports that aims to strengthen the Dutch horticulture (Greenports Nederland, 2023). The regional Greenports are geographic clusters of companies economically tied together with a join objective regarding sustainability, mobility and logistics (Wisse & Klein, 2020). They are organized as a triple helix, with the business community, education, and government, as well as relevant parties. The Greenports are the implementation tool of national policies. Since 2017, the regional Greenports have collaborated on several overarching challenges within Greenport Netherlands.

Lobby groups
The final political group affecting the Dhc sector are the lobbying parties (Glastuinbouw Nederland, 2023b; Wisse & Klein, 2020). There are four main parties that represent different steps in the supply chain namely, Plantum for plant breeding, Glastuinbouw Nederland that represents the growers, Royal Flora holland for auction of flowers and Groentenfruit huis for wholesale of fruits and vegetables.
Aside from the national government, the regional politics are also invested in the covenant through the ‘Interprovinciaal Overleg (IPO)’ which is a collective of the twelve municipalities (IPO, 2023). The IPO provides direction to the national policies on a regional level and promotes innovation and knowledge sharing of ‘best practices’.

A4.3 INNOVATION INSTITUTIONS

In this final section of the stakeholder analysis, we will discuss the institutions focused on innovation and knowledge sharing. These institutions operate at various levels, from local to national and international, and comprise a vast network of stakeholders and organizations. While it is not feasible to provide a comprehensive overview of all these entities, we will categorize them into two groups: Dhc sector-specific institutions and general innovation institutions.

Dhc sector specific innovation institutions
The Dhc sector-specific knowledge institutions aim to increase knowledge regarding cultivation methods, best practices, and promote testing and R&D regarding horticultural innovations or technologies. These institutions can be further categorized into three sub-groups: governmental institutions, research institutions, and innovation institutions.

Governmental innovation programs

Government-funded innovation programs are one of the types of institutions that focus on Dhc sector-specific innovation. Most of these institutions are funded by the government as part of the Topsector Tuinbouw en Uitgangsmaterialen. Among them are institutions such as Kennis in je Kas (KIJK), Kas als Energiebron, and Stichting innovatie Glastuinbouw (SIGN) which actively fund and promote horticultural innovations. Additionally, there are innovation funds such as LTO, which is a collaborative farmers' party (Glastuinbouw Nederland, 2023b; Wisse & Klein, 2020).

Kas als Energiebron

Kas als Energiebron is a program developed by Glastuinbouw Nederland and the Dutch Ministry of Agriculture, Nature, and Food Quality (LNV) to encourage energy-saving and the use of sustainable energy in greenhouse horticulture (Kas als Energiebron, 2023). The program focuses on developing knowledge and cultivation techniques to save energy in greenhouses by using more sustainable energy sources, such as bioenergy, sunlight, and geothermal energy. The program also encourages innovations that could make a breakthrough for the sector by involving entrepreneurs, providing knowledge exchange, subsidy schemes, and affordable technology. The program has been initiating and promoting research in this field since 2005. Its long-term ambitions are to aid the sector to reach the sustainable ambitions set by the government. As such, it is provided with a yearly budget of 3.7 billion euro. Half originating from the ministry of LNV and Topsector Tuinbouw en Uitgangsmateriale, and the other half from companies of the sector. Finally, Kas als Energiebron has additional 11 million euro 'proof of principle' budget, where sustainable startups can make use of (Kas als Energiebron, 2023).

Stichting Innovatie Glastuinbouw Nederland

SIGN (Foundation for innovation in Horticulture Netherlands) aims to develop groundbreaking innovations that go beyond the interests of individual companies and established institutions, and that serve the common interest of the sector (Glastuinbouw Nederland, 2023b; op de Beek, 2012). SIGN involves stakeholders both within and outside the sector and focuses on themes that are identified by the industry. SIGN typically looks for crossovers with other sectors, and it identifies institutional barriers that may hinder groundbreaking innovations. It signals these obstacles and raises them with the relevant institutions. Often, these innovations involve risky project starts that are difficult for other parties to invest in.

Research institutions;

The Dhc sector has a number of research institutions dedicated on improving the productivity and sustainability of the sector. This study will describe the Wageningen University & Research (WUR), Priva and Delphy.

Wageningen University & Research (WUR)

Wageningen University & Research (WUR) is a key contributor to greenhouse innovation in the Netherlands. Its research facilities are unique, featuring greenhouses for sustainable crop protection, experimental energy-saving greenhouses, and measurement

setups for early detection of crop stress and greenhouse materials research (Wageningen University & Research, 2023). The WUR collaborates with businesses, government, and academia to analyze questions and translate their findings into practical research and innovation projects. One of its specific units, the Business Unit Glastuinbouw, focuses on greenhouse horticulture innovation and operates as an independent, international research organization. Through its sustainable and efficient practices research, the WUR contributes to improving plant quality and cultivation, including enhancing crop resistance to pests and diseases, reducing energy consumption, and optimizing water use. The WUR's collaborative approach, with its vast scientific and practical knowledge and expertise, makes it a valuable partner for businesses, government, and non-profit organizations in the horticulture sector. And example of such collaboration is the KAS 2030 project.

KAS2030 is born the close collaboration of the WUR, Glastuinbouw Nederland, Kas als Energiebron, Ministry LNV and BOM Group (a greenhouse building company). KAS 2030 is a greenhouse demo location where growers and researchers can learn how best achieve zero emission cultivation in greenhouses. New technologies and innovations are tested and combined to optimize their cohesion be emission free and self-sufficient regarding water, nutrients and plant protection. The greenhouse itself has fours departments of 350 m2 cultivating strawberries, gerberas, freesias and potanthurium (Wageningen University & Research, 2022).

Priva

Another key stakeholder in the sector is Priva. Priva is a technology company that specializes in developing greenhouse automation technology for controlled environments (PRIVA, 2023). Priva offers a variety of process computers, sensors, and cloud-based software with smart interfaces that automate systems within greenhouses, optimizing greenhouse processes to create the perfect climate conditions for plants to grow exponentially. Their goal is to create optimal environments in which people and plants can experience the best way to grow. They are important not only for growers and researchers, but for sustainable startups and their innovation development too. Using their services, deeper understanding regarding the effects of new innovations can be tested.

Delphy,

Delphy is a family company which is focused on developing, testing and demonstration of new cultivation concepts and greenhouse technologies from around the world (Delphy, 2023). The Delphy Improvement Centre is a recognized research institute by the Dutch government. They conduct many privately financed experiments and have a close relationship with practice. To ensure that the knowledge is aligned with the demand of growers, experiments are set up in close consultation with a guidance committee of growers. Participants are provided with intensive advice to learn how a result comes about or identify when it may not yet be possible. A cultivation expert often is part of the growers' guidance committee, ensuring that practical knowledge is present.

Innovation institutions;

Finally, there are innovation institutions, who aim to provide expertise, training or testing locations to entrepreneurs or other innovators of the Dhc sector. This study will describe the World Horti Center, HortiTech, and HortiHeroes.

World Horti Center

World Horti Center is a knowledge and innovation center for the international greenhouse horticulture sector (Worldhorticenter, 2023). It connects stakeholders, such as businesses, education, research, and government to collaborate on innovation, connection, inspiration, and knowledge sharing. World Horti Center has a state-of-the-art research center with 38 greenhouse compartments where research is conducted by the stakeholder mentioned. It is an important actor for sustainable startups due to its international network.

HortiTech

HortiTech is a research organization located in the World Horti Center that specializes in providing custom research projects for testing sustainable innovations in their demo greenhouse locations (HortiTech, 2023). They can provide support for R&D processes and expert opinions on new cultivation methods. This makes Horti Tech an important stakeholder for new sustainable startups who need to test and validate their innovations.

Horti Heroes

The final stakeholder that will be discussed here is HortiHeroes (Hortiheroes, 2023). This organization specifically targets startups and scale-ups in the horticultural sector. They provide a "soft landing" for startups and scale-ups by connecting them to potential customers, partners, industry experts, financing, and testing facilities. HortiHeroes aims to reduce barriers to faster collaboration on a large scale and works in collaboration with various ecosystem partners, including the World Horti Center. This makes them a key stakeholder for current and future sustainable startups in the Dhc sector.

<u>General Innovation institutions</u>

Sustainable startups can benefit from non-Dhc sector specific innovation institutions. These institutions aim to drive innovation, increase knowledge formation and distribution across various sectors in the Netherlands. In this section, we will describe some key stakeholders belonging to this type of innovation institution. While we will not be able to cover all of them, we will highlight a few important ones. The national institutions we will describe are TNO and TechLeap and for the regional scale we will describe InnovationQuarter and YES!Delft.

TNO

TNO (Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek) is an independent research organization that connects people and knowledge to create sustainable innovations that strengthen the competitiveness of businesses and the well-being of society (TNO, 2023). TNO collaborates with partners and focuses on nine societal domains, including Energy and Circular Economy and Environment. Their research, innovation, and data analysis can be directly applied by businesses and governments.

TNO's goal-oriented innovation and focus on practical applications make it an essential stakeholder for sustainable startups in the Netherlands.

TechLeap
TechLeap is a Dutch non-profit organization that aims to accelerate the growth of the Netherlands' tech ecosystem (TechLeap, 2023). Funded by the Dutch government, TechLeap focuses on building a supportive environment for tech companies to scale-up and become industry leaders. The organization shares its knowledge with the entire ecosystem in the Netherlands to help founders access connections and knowledge, making it easier for startups to hire, raise capital, and expand internationally (Klimaat Ministery van Economische Zaken en, 2023).

InnovationQuarter
InnovationQuarter is a regional development agency that focuses on innovation and development in the province of South Holland. Their mission is to support innovative and fast-growing companies with funding, networks, and knowledge to help them scale up and expand. They work closely with startups, scale-ups, corporates, research institutions, and government agencies to stimulate innovation and economic growth in the region. Their main areas of focus include life sciences & health, clean tech, smart industry, and IT & tech (InnovationQuarter, 2023).

YES!Delft
To finalize, sustainable startups of the Dhc sector should be aware of incubators in the Netherlands. YES!Delft is one of the first incubators in the country, founded in 2005 Delft. The organization supports tech entrepreneurs in bringing their innovations to the market through custom startup programs, full-lifecycle services, access to market and capital, and a community of experts, corporate partners, and mentors (YES!Delft, 2023). CleanTech is among the focus areas of YES!Delft, and it is home to several sustainable startups in the Dhc sector, such as ADI.

Growers
The growers are one of the key stakeholders for Thermeleon as they are the end users of their product. As such, it is important for the startups to be in close collaboration with the growers during the finalization of their system. The wants and needs need to be fully understood as well as the effect of the product on the plants and greenhouse systems. Currently the startup is in close collaboration with their lead user Koppert Cress. This collaboration enables the startup to co-create and test new means of utilizing their THB on larger scale. The growers have shown great interest in to the energy reducing potential (Figure A4.1).

Greenhouse builders
Next are the greenhouse builders. There are numerous systems and step that need to be taken when a greenhouse is constructed or retrofitted such as integration of irrigation, internal transport, steel construction, internal climate systems, systems optimization, automation. Some greenhouse building companies specialize and some or multiple of these steps for the construction of a greenhouse. There are also companies who perform

'turn-key' projects, which means they take responsibility for all stages of construction until the greenhouse is fully operational. For Thermeleon, the companies that could be future clients are the ones that; sell and optimize (1) internal climate systems, (2) screen systems, or (3) those who deliver turn-key projects. The startup is currently in close collaboration with their first client and instillation partner Brandsen group. This company has worked together with the grower Kopper Cress and Thermeleon to co-create the MVP version of the THB. Brandsen group has a relative high interest in the success of the THB, as it will distinguish them from their competitors. It also has enough power to influence certain design requirements for installation of new iterations of the THB (Figure A4.1).

Growers advisors
Advisory companies for growers can be categorized in three groups, (1) energy advisors, (2) cultivation advisors, and (3) purchasing advisor. These advisors are very valuable for the growers, but also for Thermeleon. For Thermeleon, it is very important to prove to these advisors how useful their innovation is so that growers are more likely to buy their product. One of the largest advisors is AAB (Figure A4.1). AAB is an advisory company that provides is growers with not only cultivation and (sustainable) energy advise, but also performed modeling studies to optimize their practices. Let's Grow is another advisory company with a different approach. This company has created a platform where knowledge, advise and tools are provided to their clients. It also has a tool which aids the growers in adapting their systems such that the new innovation functions well in their greenhouse. These companies are very important for the startup. This is because Thermeleon has almost no knowledge on how to best implement their product with existing greenhouse systems to maximize its effect. These companies could therefore prove very useful for not only sales, but also process optimization for integrating the THB into the greenhouse systems of their future clients.

Growers Associations
Previously was mentioned that growers associations are active in trading of products sold. However, another core activity of such organizations is the knowledge sharing and investing in sustainable innovations. As such, growers associations are very important for Thermeleon. One of the largest Dutch growers associations is Harvest House (Figure A4.1). With their network of growers, gaining the trust of these grower associations would therefore help diffuse their product across the sector.

Suppliers
In deliberation with Thermeleon, no names of the suppliers of the startup will be mentioned. This is due to the fact that the startup does not have a patent for their technology. However, as is the cost for most companies, good ties with suppliers can only be beneficial. Building long term relations can reduce the prices of the products needed to produce the THB which could future improve the value delivered to the clients (Figure A4.1).

Dhc sector specific knowledge institutions
Thermeleon has close relations with some horticulture specific knowledge institutions and experts. These experts provide insight into energy systems of a greenhouse and other

cultivation methods which the startup needs to take into account for the design of the THB. Important stakeholders which are in contact with Thermeleon are; Kas als Energiebron, Wageningen Universiteit & Research (WUR), Priva, HortiTech and HortiHeroes (Figure A4.1). Kas als Energiebron has been an important source of financial support for the startup as well as a source of knowledge. KAE hosts multiple events in which Thermeleon participates and shares concerns and troubles growers face, which give insight into the situation of the growers. WUR has provided the startup with students who join the startup for their study projects, which furthers the knowledge capital of the startups. Priva and HortiTech are highly valued horticultural knowledge institutions. These stakeholders provide Thermeleon with demo-locations and expertise to collect data regarding their product. HortiHeroes provide Thermeleon with a network of fellow startups and companies that aids the distribution of awareness of the THB across the sector.

Independent Innovation institutions
Another stakeholder group are the innovation institutions. As previously described these institutions support startups with financing, network and knowledge. Thermeleon is currently in collaboration with InnovationQuarter, and YES!Delft (Figure A4.1).

Competitors
Currently, Thermeleon does not face any direct competitors, as the THB can work in tandem with other greenhouse systems and technologies. There is currently no other company that produces any 'HeatBattery" based on the same technology in the Dhc sector. However, there are other types of energy saving or heat-storing technologies which form indirect competition. After all, the budget of the growers is finite meaning they cannot invest in all energy saving options there are.

The startup has three groups of competitors. However, only two groups will be discussed in this study, namely the sustainable energy or energy saving competitors and screen providing companies. The sustainable energy technologies for the Dhc sector are the following; geothermal energy, water buffer tanks, Thermitube, Solar panels for the roof and floating solar.

As previously stated, the Netherlands wants to use Geothermal energy as a new sustainable energy source for the Dutch horticulture (Geothermie.nl, 2023). In order to accomplish this, more locations are being constructed. For geothermal energy to be used for both the Dhc sector and other sectors, the Netherlands aims to open another 35 adding to the existing 24 locations. And a new "heat network" of underground pipelines are needed. These are enormous investments which the local and national government need to make. For the growers however, it means that they have to invest and help construct pipelines to connect to the Heatnetwork. This can of course, only be done for the growers close to the current 24 injection points.

Water buffer tanks (WOT) are systems for which water is used to 'store' excess heat during summer months, into tanks or basins wither above or below the ground. This heat is then used during the winter months to heat the greenhouse. While this technology sounds

similar to the THB, it is quite different. The water buffers system is an active system, which means that is used energy to pump the water around and transfer the heat. The technology can also be used in tandem with the THB.

Next is a company called Thermitube, which makes a special tube filled with air and places this close to the plants (Thermitube, 2023). This tube gets heated by the sun and then stores the heat in the air pocket. This excess heat s then passively distributed in the greenhouse and could reduce the need for additional heating. This is relatively similar to the THB. However, the technology is not yet diffused in more greenhouses. The company is based in France which is outside the scope of this study. What can be found however, is that few large scale greenhouses use their technology at the time this study is being performed.

Solar panels form the final source of competition in regards to sustainable energy. In the horticultural sector, solar panels are used more often. Not always on the roofs, but often on nearby roofs or pieces of land (Bakker, 2020; Cuiper, 2020). With the improvement of the solar panel efficiency more greenhouses see the use of solar panels. Aside from being a large investment, the utility of such systems is largely dependent on the other collaborative systems in the greenhouse, such as the water buffer tanks (Kanbouwen.nl, 2020). The surplus of heat and energy from the solar panels can be stored in those tanks which increases the utility of the solar panels heavily. Furthermore, new projects of solar panel placements have emerged, such as floating solar (Solar, 2023) . For this project, solar panels are placed on large bodies of water using floating material. This setup is very useful in areas with large lakes, yet not as much for all greenhouse owners.

Aside from these sustainable investments, growers may also choose to invest in new or additional screens. Screens are a necessity for the current greenhouses in the Netherlands. These screens vary in their use, but most tend to have an energy saving function due to isolation. Many greenhouses have at least one type of screen installed, yet a trend has been observed in growers investing in a second or even a third screen (Ludvig Swennson, 2023). The company with the largest market share for greenhouse screens is Ludvig Svensson (Ludvig Swennson, 2023). This company produces, installs and maintains screens in many countries. Their products can be categorized in 4 function groups, namely screens for light diffusion, energy saving, solar control and blackout screens. Growers might be more willing to invest in additional screens at there are likely to be cheaper then THB. However, for growers who already have multiple layers of screens, other investments might be more interesting. Thermeleon should thus focus more on the growers who already have multiple screens and are looking for other type energy reducing innovations.

APPENDIX 5: SUPPORTING DOCUMENTS

In this appendix, the supporting documents for the thesis report will be provided and briefly described.

The STN Model

The STN model was made in an online tool called Miro. The Miro board link is posted below such that the reader can view the board while reading this thesis report.

https://miro.com/app/board/uXjVMJxbPb4=/?share_link_id=595735776395

Detailed application of the STN model

The STN model was applied to two case study startups. The detail description of this application and the corresponding strategic advice has been provided to the startups. Based on the supplied strategies, feedback was provided to this study as described in Appendix 2. Below are the names of the two documents supplied to the startups as reference.

#1: “STN model for Thermeleon”

#2: “STN model for FOTONIQ”