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1. CASE STUDY STARTUP | THERMELEON

This chapter the theory and findings of the previous chapters will be applied to current sustainable startups in the Dhc sector. This will serve as examples for future startups. We will apply the TIS framework to the business models of those startups to determine what niche strategies they could utilize. Then we will review these niche strategies for their ability to overcome the barriers found in Chapter 5 and then choose the strategy that best overcomes all barriers and utilized the drivers of the sector. Next, we will describe how the incomplete or incompatible TIS building blocks are described by the BMC of the startup. This will be followed by a description of how the advised niche strategy can be adopted by the BMC and how it could affect it. The startup will first be introduced and their business model described.

1.1 THERMELEON

Thermeleon started in 2017 and aims to provide a novel heat storing device named the *"Thermeleon Heat Battery"* (TBH). The battery absorbs energy during times of heat excess, which happens mostly during the day. This stored energy is then release in times when the greenhouse is in need of heat, usually at night. Therefore, the Heat Battery has both a heating and cooling function. In addition, the Heat battery provides thermoregulation during the day without emitting CO2 inside the greenhouse or usage of water. Thermeleon claims their product can save up to 20-30% of the fossil fuels used for heating and reduce carbon emissions by lowering the need to cool by opening the windows of the greenhouse.
When referring to the 9 sustainable business model archetypes of Ritala *et al.,* (2018), Thermeleon's Heat Battery best fits the 'substitute with renewables and natural processes' archetype of the technological grouping (Bocken et al., 2014; Ritala et al., 2018).

1.2 TIS FRAMEWORK APPLICATION

Next, the TIS framework as described by Ortt & Kamp (2022) will be applied to the startup. This will be done by asses the status of the seven building blocks first, followed by the status of the seven influencing factors.

1.2.1 STATUS OF THE BUILDINIG BLOCKS

During a brainstorm with both founders and the rest of the team of Thermeleon, the status of the building blocks of the startups were discussed. The status of each building block will be described individually (Figure 6.1).

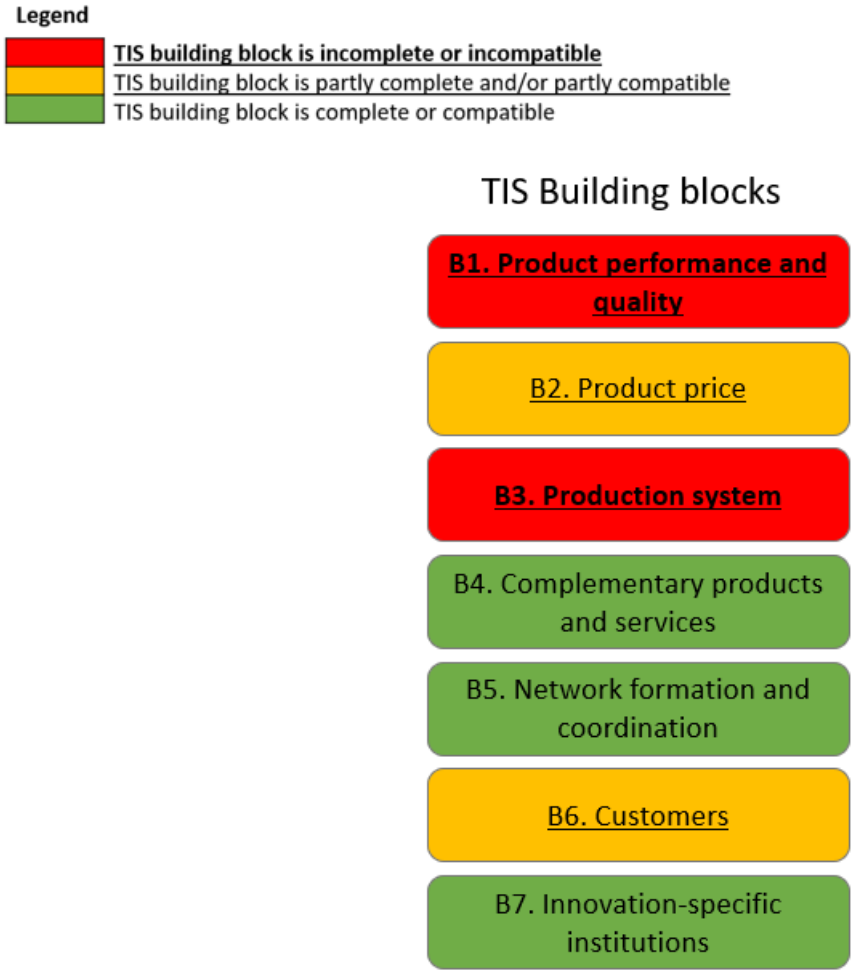


Figure 6.1 Status of the TIS building block for the Thermeleon HeatBattery

B1. Product Performance and Quality:

For this building block, we will look into the compatibility for large scale diffusion of a singular Heat Battery unit and the fully integrated system of multiple Heat Battery units. The performance and quality of the singular heat battery unit is described using two characteristics, namely; the heat capacity and the light transmission. The heat capacity should be as high as possible. This maximized the amount of energy a single unit can store thus reducing the amount of units needed per greenhouse. This increases the quality of the system, since fewer units needed means lower costs for the grower. The light transmission is for many growers an important subject. Certain crops need as much light as possible (e.g. tomatoes, paprika's, gerbera's), while other crops do not need as much light (e.g. orchids, freesia's, cucumbers). Based on their own market research, the light transmission of their THB is high enough for certain crop types. Based on the measurements of both characteristics, the performance and quality of a singular unit is compatible for large scale diffusion.

For Thermeleon, the goal is to reduce as much of the energy utilization of a greenhouse as possible, but the current target of 20-30% for their first clients. However, if this is possible has not been tested yet. This is due to the current state of the production process of the startup. Current estimates are that around 100 m^2 of Heat Batteries are necessary for a greenhouse of 1.000 m^2. In recent years, the overall size of greenhouses has

increased, resulting in most greenhouses having around 2 hectares (20.000 m^2) of surface area, meaning that around 2.000 m^2 of heat batteries is needed for the first large scale test. As can be imagined, this is a rather large production number for a startup to construct. This has resulted in several unknown performance and quality indicators of the technology. Thermeleon does not yet know how well the system functions in large scale, with other climate systems in the greenhouse, nor does it know if the target reduction of 20-30% can actually be reached for the greenhouses they are currently working with.

Overall, we argue that for this TIS building block, the Thermeleon Heat Battery is not compatible for large scale diffusion. While the quality and performance for a singular unit in small scale has shown to be high, little is actually known for true scale greenhouses.

B2. Product Price:

In regards to the Product Price, both financial and non-financial cost of procurement are important. In order for this building block to be compatible with large scale diffusion, the total production price should be as low as possible for both the customer as well as the startup. We will first discuss the customer side. The financial price for the consumer consist of both the financial costs of procuring and installing the THB. However, since the THB should reduce energy utilization, the future financial savings of energy and/or fossil fuels also need to be taken into account. Thermeleon will sell the THB per m^2, meaning that the total price for a future customer will depend on the amount of units sold, which depends on the greenhouse size and the wishes of the grower. However, based on the inhouse calculations of Thermeleon, the total price of the TBH for a greenhouse should be comparable with other more widespread greenhouse technologies, such as thermal screens, spray technologies for cooling, geothermal heating network. Additionally, the price of energy and fossil fuel have been increasing to historical heights, due to the war in Ukraine. For some growers, this might vary. This is due to the nature of certain energy contracts. Growers might have signed contracts which have set a price of energy or fossil fuel for a certain number of years for a set price. This price is in all cases much lower than the current prices. From the interviews some growers stated the following; "*I already know for sure that 2024 will be my most profitable year of my career…"*. Other with no fixed contracts have it much more difficult. As such, the potential future savings for a grower are very high, which reduce the overall Product Price. However, as previously stated, the true effects on the energy consumption of a grower are not yet measured on true scale, and as such, the overall financial costs of savings are unclear.

The non-financial costs for a customer pertain to all things needed in order to have the new product work optimally in their greenhouse, which have no clear financial cost. These include the time investment to install the THB, changing the systems setting of heating and other technologies to work together with the THB, the effort of the grower to learn how best to work with the new technology. In order to minimize these costs, Thermeleon plans to work together with greenhouse builders, to install the THB, and knowledge institutions, to see how best to integrate the THB with existing greenhouse technologies. However, since it is still unknown how much such systems need to be adapted and how well the TBH will work with those systems, this price is difficult to determine.

For the startup, the Product Price should also be compatible for large scale diffusion. Financially, the costs of the necessary resources to make the THB are relatively low. Based on the current relations with suppliers, future costs of materials might decrease as the size of shipments increase. Additionally, the product should be easily recyclable. The plan is to return each product sold after its shelf life is reached, after which around 90% of the products should be able to be recycled. This would reduce the product cost for the startup and the environment.

Overall, we conclude that for this building block is partly compatible for large scale diffusion. The financial costs are low for both the startup and the customer. However, since the non-financial cost for the customer are still unknown. Furthermore, there is no example for the installation and implementation of the technology into an existing greenhouse with its own technological system. Only when this is known and managed well, can this building block be fully compatible for large scale diffusion.

B3. Production System:

For the Production System to be compatible or large scale diffusion, it should be able to produce enough heat Battery units to cover the Dhc sector within reasonable time. Based on the CBS database, there is around 5.000 ha of greenhouses in the Netherlands. This means, that around 500 ha of THB could potentially be sold in the Netherlands alone. Currently, Thermeleon is able to produce 5m2 of THB in 1 week. With the current production speed to produce enough product for the whole Dhc sector would take 7 million days. This means that the Production System is not ready for large scale diffusion.

The issue with the current production line is the human resources needed. While the assembly of the materials needed is rather easy and has few steps, it currently needs at least two people to perform. Additionally, in their current location and size of their team, Thermeleon is only able to work on one unit at a time. This greatly hampers the speed of production. The production line can be fully automated in the future, however the startup is not ready yet for such a system. As such, the overall conclusion is that the Production System is not ready for large scale diffusion.

B4. Complementary products and services:

There are a number of Complementary products and services customers can make use off. One of them is the strong network of knowledge institutions in the sector. This has been partly discussed in the stakeholder analysis. The Dhc sector has numerous parties which study greenhouse technologies and their implementations. These parties, can be hired by growers separately, or by the startup itself, to form a plan how best the THB can be implemented in the system of technologies per greenhouse. Additionally, many growers are in close contact with advisors or other experts, who they consult before procuring a new innovation. These experts can also advise which products can be better used for improvement.

Additionally, the THB does not supersede the use of any existing greenhouse technology, but should be able to working in tandem with other technologies. As such, if a grower already invested in energy saving innovations, adding the THB can still be useful. Furthermore, knowledge institutions such as the WUR and Priva have invested in the

production of new measurement equipment to study the environment in the greenhouse. This has resulted in the formation of new temperature, CO2 and other measurement systems. These new measurement tools are currently used optimize the greenhouse climate for growth. Such systems can also be used to better integrate the THB in the greenhouse.
Finally, initiatives such as KAS2030 aim to find the optimal greenhouse system and cultivation method for the sustainability goals of 2030. This could be seen as service to growers since a different team will study and test new technologies and see how they should cooperate.
To conclude, this building block is very compatible with large scale diffusion. There are numerous technologies, measurement tools and knowledge institutions that can be utilized for growers to learn how best to implement the THB in their greenhouse.

B5. Network formation and 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 the THB, many more growers will want to incorporate this new technology in their own greenhouse, and knowledge institutions will look into the method to make most use of it.

Aside from the sectoral network, the startup specific network should also be regarded. Due to the network of the sector, distribution of the THB, once produced, can be managed very easily. Due to the strong network of the Greenport, distribution can be done easily within Greenports and from one Greenport to the next. Furthermore, the relations with installation partners are also formed and coordination of various installation parties can be done smoothly due to the nature of the sector. Finally, the network of suppliers is
To conclude, the Network formation and coordination is complete and compatible for large scale diffusion of the THB.

B6. Customers:
During interviews with growers and horticultural institutions, we gained insight into their mentality and learned that in order to fully describe the compatibility of the THB building block, we need to consider both the overall mentality of the growers with sustainable innovation in the Dhc sector and the technological specifications of THB specific to the customer's needs.

In terms of the growers' overall mentality, they are generally open to new innovations and continuously seek new cultivation techniques or other means to increase production or sales. This is driven by both their innovative nature and the pressure of the sector to continuously innovate. However, the number of growers has been decreasing due to

fierce competition and the energy crisis, which has increased the need to innovate even further. Despite this, or maybe because of this, growers are risk-averse and are often only willing to invest in innovations that are low-risk and have already been proven to work in similar greenhouse systems. They are not generally trusting of scientific findings and prefer to implement innovations that have shown results in functioning greenhouses.

In the case of Thermeleon and their THB, customers are not willing to invest in a technology that has not shown functionality in a fully operational greenhouse. However, due to the energy crisis and pressure of the sector, some growers are willing to take risks and participate in co-creation to further develop the THB. Nevertheless, they are not willing to invest money in the product and expect the startup to carry most of the risks and payments. Growers who currently have a THB prototype in their greenhouse do not yet know how to adapt their systems to this new technology. This is something Thermeleon needs to address before they are able to increase the diffusion of their product. Growers would likely be willing to invest in the product once it has been proven to work in the greenhouses where prototypes are currently in use.

Therefore, we conclude that the THB building block is partly compatible for large-scale diffusion. Other startups with sustainable innovations that wish to provide their technology to growers in the Dutch horticultural sector may find the overall mentality of growers towards innovation useful, but they will also need to address the specific technological specifications of their customers.

B7. Innovation-specific institutions:

The innovation specific institutions will be divided into the following parts; the horticultural innovation institutions, the sector, and the government.

As previously mentioned, the network of knowledge and innovation institutions is very well developed in the Dutch horticulture. There are numerous institutions, on regional and national level, which are dedicated to helping horticulture innovate and transition to a more sustainable way of production. These institutions include parties as; Kas Als Energiebron, Priva, HortiTech, HortiHeroes and others. These parties can aid in development of the startup, technology and awareness in the Dhc sector.

Another positive addition to this is are the subsidies of the government in the sector. Due to the sustainable goals of the Dutch and European institutions, a large number of subsidies and grands are available to growers who which to invest in sustainable innovations such as the THB. Thus to conclude, the building block of innovation-specific institutions is compatible for large scale diffusion of the THB.

Conclusion of the building blocks

During this section of the report, the status of the seven building blocks of the TIS framework by Ortt & Kamp (2022) were analyzed for the startup Thermeleon and its product the HeatBattery.

The assessment of these building blocks suggests that three building blocks are compatible for large scale diffusion. These are; the Complementary products and services, Network formation and coordination, and innovation- specific institutions. This means,

that these block from no barriers are formed from these three perspectives. On the other hand, the other four building blocks are not ready for large scale diffusion, as building blocks; the Product Price, and the customers are partly compatible, while the Product Performance and Quality, and Production System are not compatible for large scale diffusion. According to Ortt & Kamp (2022), these incomplete building blocks should be the cause of barriers hindering the diffusion of the THB.

1.2.2 STATUS OF THE INFLUENCING FACTORS

Next, we will assess the influencing factors of the case study startup. During this section, the effect of the influencing factors on the building blocks will be described as well as their link with niche introduction strategy formation (Figure 6.2).

In the previous section, we found incomplete or incompatible building blocks that form barriers to large scale diffusion innovation. In order to address and overcome these barriers, Ortt & Kamp (2022) proposed to from niche introduction strategies. For these strategies, the cause of the barriers are needed in addition to their nature. The building blocks of the TIS framework guides us to the nature of the barriers, while the influencing factors help us find the causes of the barriers. In this section, we will assess the influence of these conditions on the startup's building blocks and their link with niche introduction strategy formation.

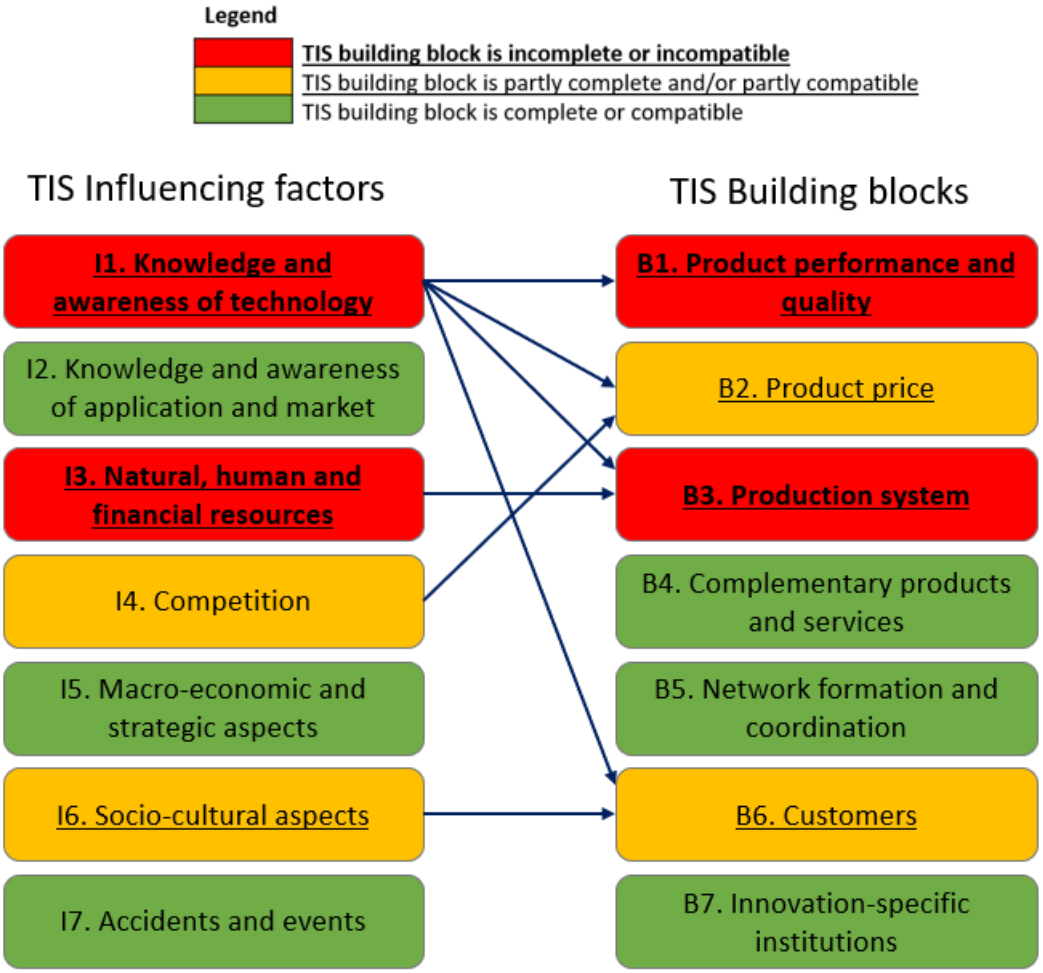


Figure 6.2 TIS framework applied for the Thermeleon HeatBattery
This figure depicts the status of the seven TIS building blocks and seven influencing factors. The legend above provides an overview of the three states and their associated formats and colors. The arrows in the figure indicate the influencing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

Knowledge and awareness of technology

Thermeleon has a specific functional knowledge of the single Heat Battery unit. The company knows how much energy can be stored per unit, as well as the light transmission through them. Furthermore, they possess knowledge about the potential use of the Heat Batteries and the benefits towards greenhouse cultivation. They have also conducted simulations on possible energy savings, potential reduction of fossil fuel demands, and effects on the heating and cooling of the greenhouse during the day and per season

However, the company has no knowledge or data of real-world results. No tests have been conducted in a functional greenhouse with enough Heat Battery units to cover a potential greenhouse. There is no knowledge of the effects the units can have on plant quality, if the plants will suffer from thermal stress, what the effects are on the humidity in the greenhouse, if condensation will occur on the heat battery units or on the leaves of the plants, or if the production of biomass is affected. The company also lacks knowledge of how the cultivation systems in the greenhouse should be changed to adopt the Heat

Batteries. Finally, Thermeleon has no practical experience with the upscale production or installation of the heat batteries
The conclusion is that the knowledge and awareness of the technology is not enough to be compatible with large-scale production. This affects four TIS building blocks, namely:

- Product Performance and Quality: The lack of knowledge regarding the effects on a true scale affects the performance in the greenhouses and integration with other systems of the greenhouse and the quality of the service for the growers.
- Product Price: With no knowledge of actual results in operational greenhouses, the true positive impact cannot be determined, and thus no payback time can be calculated. This also affects the price of non-investment.
- Production System: This building block is affected because the MVP of the product can change in form after the first results are obtained. This will cause the Production System to change. This change is certain, which is why no more time is invested in building a better Production System since it will likely need to change anyway.
- Customers: The lack of true scale results makes future customers hesitant to invest.

Knowledge and awareness of application and market

The Thermeleon Heat Battery is a promising innovation in the field of greenhouse technology, and as with any new product, knowledge and awareness of the application and market are crucial for its successful adoption.
The startup has identified which crops have less need for light, making it easier for them to target growers who are more likely to accept their product with 70% light transmission. Additionally, they have compiled a list with a number of innovators in the industry who are willing to co-create and test out the product on a larger scale. These are both important steps in building a customer base and establishing credibility in the market.
In conclusion, the knowledge and awareness of the market is not limiting the startup ability to scale up the diffusion of the Thermeleon Heat Battery.

Natural, human and financial resources

Next is the influencing factor of resources. The products and base resources needed to produce the Thermeleon Heat Battery are relatively cheap and not scarce. This means that in regards to their natural resources, noting is hindering the startup.

However, there are negative aspects to their human and financial resources. The current Production System is very dependent on human actions and time-intensive. Currently, the team is not large enough to handle upscaling of the production process based on this. The small team also lacks human experience and skills to improve the Production System, resulting in some leaking units. Additionally, the team does not have the knowledge and experience in optimizing the integration of the HeatBattery in existing greenhouse systems. Finally the company's financial resources are slim and the startup is dependent on grants and investments.

The conclusion is that the natural, human, and financial resources are not compatible with large-scale diffusion. This affects the following building blocks:

- Product quality and performance: There are not enough skills to make the product with enough quality, resulting in potential performance issues.
- Production System: There are not enough human resources for an increased rate of production, not enough financial resources to fund a larger-scale Production System, and a lack of knowledge of what the system should look like.

Overall, Thermeleon needs to address their human and financial resource limitations to scale up their Production System and improve the quality and performance of their product for successful large-scale diffusion.

Competition

The competitors of Thermeleon have been previously described in Appendix 4. There, we stated that there are no direct competitors to Thermeleon's Heat Battery, as it can work in tandem with many other types of technologies. However, there are many different types of energy-saving alternatives available in the market, some of which are cheaper while and others are more expensive. Some of these alternatives have already been integrated into other greenhouses, producing results that Thermeleon has not yet been able to replicate.

As a result, the competition factor is only partially compatible with the large-scale diffusion of Thermeleon's technology. This affects the Product Price building block. There are many competing products in the market, and growers may choose to invest in them instead of the Heat Battery because its unknown or unproven effects. Those unknown factors negatively affect the Product Price, because the growers are unable to calculate the payback time of their investment, not gauge the potential costs of implementation.

Macro-economic and strategic aspects

The Thermeleon Heat Battery appears to be well-suited to the macro-economic landscape of the Dutch horticulture sector. Due to its status as a TOPsector the Dutch government has been attached great importance to the horticultural sector and it is actively promoting sustainable innovations for the sector. Additionally, there is high economic pressure for the sector to improve and innovate. With the stark inflation of fossil fuels and energy prices, growers have especially felt an increased pressure to reduce their energy consumption. These factors suggest that there is a receptive market for sustainable innovations like the Thermeleon Heat Battery.

However, the negative aspect of growers being risk averse could potentially hinder the widespread adoption of the technology. Furthermore, the current energy crisis might have put certain growers in financial stress, lowering their willingness to invest in new and unproven technology. However, the moment Thermeleon shows the effectiveness of their product in a functional greenhouse, most growers will likely show great willingness to invest in the THB.

Overall, the macro-economic aspects are mostly compatible with large scale diffusion, but the success of the Thermeleon Heat Battery may depend on how effectively the company demonstrate its effectiveness and reliability to the market.

Socio-cultural aspects

Using the knowledge gained from the previous chapters describing stakeholders, barriers and drivers of the sector, the socio-cultural dynamics could be discerned to some extent. Based on this understanding, the Dutch horticulture is a sector which is very willing to innovation in regards to production efficiency, but hesitant to rake risks. In addition, once a new innovation is adopted buy a certain grower, their competitors are very likely to adopt it as well. As such, the socio-cultural aspects of the sector have both positive and negative effects on the product adoption in the industry.

On the positive side, many growers are open to innovate, especially regarding improvements to their crop quality. Additionally, growers have a strong sense of cohesion, and if one grower approves, others tend to agree as well. However, this cohesion can also be negative for new startups trying to introduce new technologies, as they face reluctance from growers who are hesitant to change their traditional cultivation methods. Growers may be hesitant to adopt new non-field tested technologies, and they are less susceptible to sustainability statements if no clear additional benefit to their crops or finances is shown. As such, at the current stage of the startup, the socio-cultural effects hamper the startup, that affect the following building block.

- Customers: the growers are hesitant to adopt the innovation in the current state where little results are available regarding its effect in the greenhouse environment. The startup needs to reduce the perceived risks of the growers before they are willing to adopt the product. However, once the product has shown its effect in a functional greenhouse and gained the approval of some growers the product will spread more easily across the sector.

In conclusion, the socio-cultural aspect of the Dutch horticulture sector present a challenge to the diffusion of the Thermeleon Heat Battery. The reluctance of growers to adopt new technologies that might influence the widespread adoption of the technology.

Accidents and events

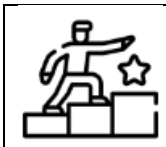
The most recent accident and event that might affect the diffusion of the THB is the war in Ukraine. Despite it being a very tragic event, is can lead to a faster spread of energy-reducing technologies such as the THB. Due to the war, the energy and gas prices have increased significantly in recent times, resulting in a greater need for reducing energy consumption. This has made it more desirable for growers to find ways to reduce energy costs, which is very beneficial to startups like Thermeleon that provide innovative energy-saving solutions.

1.3 NICHE STRATEGIES TARGETING TIS BARRIERS

Now that the TIS building blocks and influencing factors have been assessed, it is possible to assign niche strategies of Ortt et al., (2013) in order for the startup to overcome the corresponding barriers. Aside from assigning possible niche strategies, this study will aim to formulating a strategy specific to the start and their current situation. This will serve as an example for future sustainable startups on how to apply certain strategies to their own situation. Based on the status of the TIS framework, the following niche strategies could be utilized (Table 6.1).

Table 6.1 Description of niche strategies possible for Thermeleon with similar TIS situation

Generic niche strategies	**Description of the niche strategy**	**TIS situation**
Demo, experiment and develop niche strategy 	A niche strategy can be adopted to demonstrate the product in public in a controlled way so the limited quality of performance is not a problem. As part of the strategy experimenting with the product is important to develop the product further, for example in a research environment.	• Lacking Knowledge of tech (I1) affects Product quality (B1)
Redesign niche strategy 	A strategy to redesigned a product and position it in a different application to better fit the market situation. The redesign can refer to a simpler version, which can be produced at a lower price. A redesign can also be created for an application in which it better conforms to the market situation.	• Lacking Knowledge of tech (I1) affects the Product Price (B2) or Production System (B3) •Lacking Resources (I3) affects the Production System (B3) • Hindering Socio-cultural aspects (I6) affect the availability of Customers (B6)
Hybridization or adaptor niche strategy 	A strategy to use the product in combination with an existing product, allowing the use of existing complementary products and services. For example, providing an adaptor to make the product compatible with existing products.	•Lacking Knowledge of tech (I1) affects the Complements (B4) • Lacking Resources (I3) affects the Complements (B4)
High-end niche strategy 	A niche strategy can be adopted where hand-made products can be made to order, in small numbers, for a specific top-end niche of the market.	• 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)
Lead user niche strategy	A strategy aimed at innovators or lead users, whereby the product can be co-developed. Firms can learn about suitable designs, as these highly	• Hindering Socio-cultural (I6) affect Customers (B6).

	involved and expert users experiment with the product and develop it further.	
Subsidized niche strategy 	A strategy to subsidize the product development with public funds. This is possible if society considers a particular segment of customers' use of the product relevant or important.	• Lacking Knowledge of tech (I1) affects the Product Price (B2) or Production System (B3) •Lacking Resources (I3) affects the 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.	• Hindering Socio-cultural (I6)) affect Customers (B6)

These strategies can be implemented differently based on the situation or creativity of a business leader. However, this study has formulated a potential method of implementation based on the current situation of Thermeleon (Table 6.1). Using the list of strategies and their potential means of implementation an encompassing strategy can be formulated.

1.3.1 OVERARCHING STRATEGIC ADVICE THERMELEON

In this section an overarching strategy will be formulated by applying the niche strategies to the Thermeleon startup case. This was done by first determining the most hindering influencing factor for the startup. For this strategy, multiple possible outcomes will be described as well as what the startup should do in those cases. This will be visualized into a timeline (Figure 6.3).

Currently the most hindering factors for Thermeleon is their lack of practical knowledge of their technology and their lack of human and financial resources. Due to the lack of knowledge the startup is not able to provide their customers with results showing the performance of the THB in reducing the energy requirements of a greenhouse, nor how the THB affects the other systems in the greenhouse. This in turn affects the price calculation of the growers, since they are unable to determine the right payback time of the THB, reducing their desire to invest in the product. Finally, the lack in knowledge of the product hampers the startup from fully committing to an improved Production System in case the product needs to be redesigned based on the performance of the prototype in a functioning greenhouse.

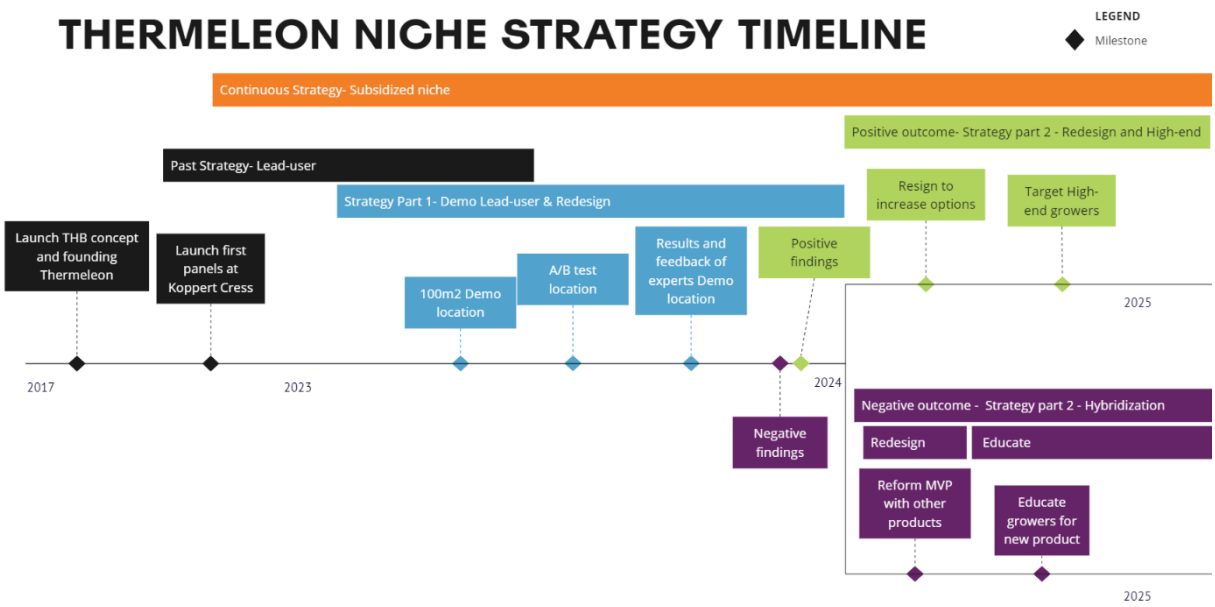


Figure 6.3 Timeline for niche strategy implementation

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.

Therefore, this study suggest that the startup should first improve the status of this influencing factor by implementing the 'demo and development niche strategy' in tandem with the 'Lead user niche strategy' (Figure 6.3). The demo and development niche strategy targets the lack in knowledge and awareness of their technology by setting up a smaller sized version of their product in an experimental greenhouse. This would provide the startup with necessary data regarding the effect of the THB in such a greenhouse instead of a laboratory setting. With the smaller size of the demo location, the problems of the large greenhouse size and slow Production System are also circumvented. This report urges Thermeleon to utilize the demo location as an opportunity to increase understanding of three building blocks, namely; the Product Performance and Quality (building block 1), the production process (building block 3) and the customers (building block 6). HortiTech could be a potential partners for such a demo location, as they also provide expertise in how best to utilize their facilities. This would give the startup more insights into the effect of the product and what growers might want to see based on the advice provided by HortiTech.

Aside from the 'demo and development niche strategy', the 'Lead user niche strategy' could be implemented. For this strategy, an innovative grower is needed where the THB can be installed in partial steps. The Lead user niche strategy is method to increase the knowledge of the application of the product by co-creating with a lead user. Currently, the startup is already performing this strategy. Thermeleon is in close collaboration with a grower and has developed their product in their greenhouse in a step by step way. However, the greenhouse of their lead user is still rather large, which has resulted in the

startup being unable to obtain any data from this setup as they do not have enough THB units to measure any significant effect. This is why this study urges to also perform the demo and development niche strategy in a smaller greenhouse to better measure the energy reducing effects in a demo greenhouse. By combining the demo niche strategy with the lead user niche strategy, the startup is able to gain both knowledge of the technology and its application. Ideally, Thermeleon should utilize the demo location of HortiTech to gain the necessary technical knowledge of the product, such as the energy reducing effect in the smaller location, the effect on the internal greenhouse climate and on the plants. From the lead-user location, the startup should learn how best to apply the product in a larger operational greenhouse and gain the feedback on the design from the lead user. Furthermore, gaining the 'mark-of-approval' from the lead user can increase the willingness of other growers to invest in the THB through the socio-cultural aspects of the sector. The implementation of these two niche strategies combined can lead to two possible outcomes; a 'positive case' or a 'negative case'.

Positive case
In the positive case, the startup has learned from the demo and development niche strategies that the product works as expected, and it reduces the desired amount of energy of around 20-30%. Furthermore, the startup has gained the knowledge of the effects of the product on the internal climate of the greenhouse (e.g. humidity, airflow). No negative effect on the plant were found and the little to no product alterations are necessary based on the lead user's feedback. In this case, the knowledge of the technology improved, which improved the TIS building blocks. Additionally, by making use of the socio-cultural aspects, customers are more willing to test the new innovation (Figure 6.4).

Should this case come to pass, the next step would be to target the lacking Resources and Production System. These could be improved using the Redesign niche strategy, Subsidized niche strategy and the High-end niche strategy.

With the feedback obtained from the Lead-user and the HortiTech experts, the prototype of the THB can be redesigned. The goal of this redesign strategy is to make a product the startup can commit for a longer production period. This would allow the startup to invest in a new Production System which can be less dependent on human labor and be more automated. This would reduce the skill required of the startup team. Another option would be to outsource the assembly of goods to their production partners.

With the current political and financial situation of the Dhc sector, there are numerous subsidies available for the procurement and development of sustainable innovations in the Dhc sector. As such, growers are able to use subsidies which lowers investment cost of sustainable innovations. Currently the startup is already making use of governmental sustainability grands and is aware of all subsidies they and the growers can make use.

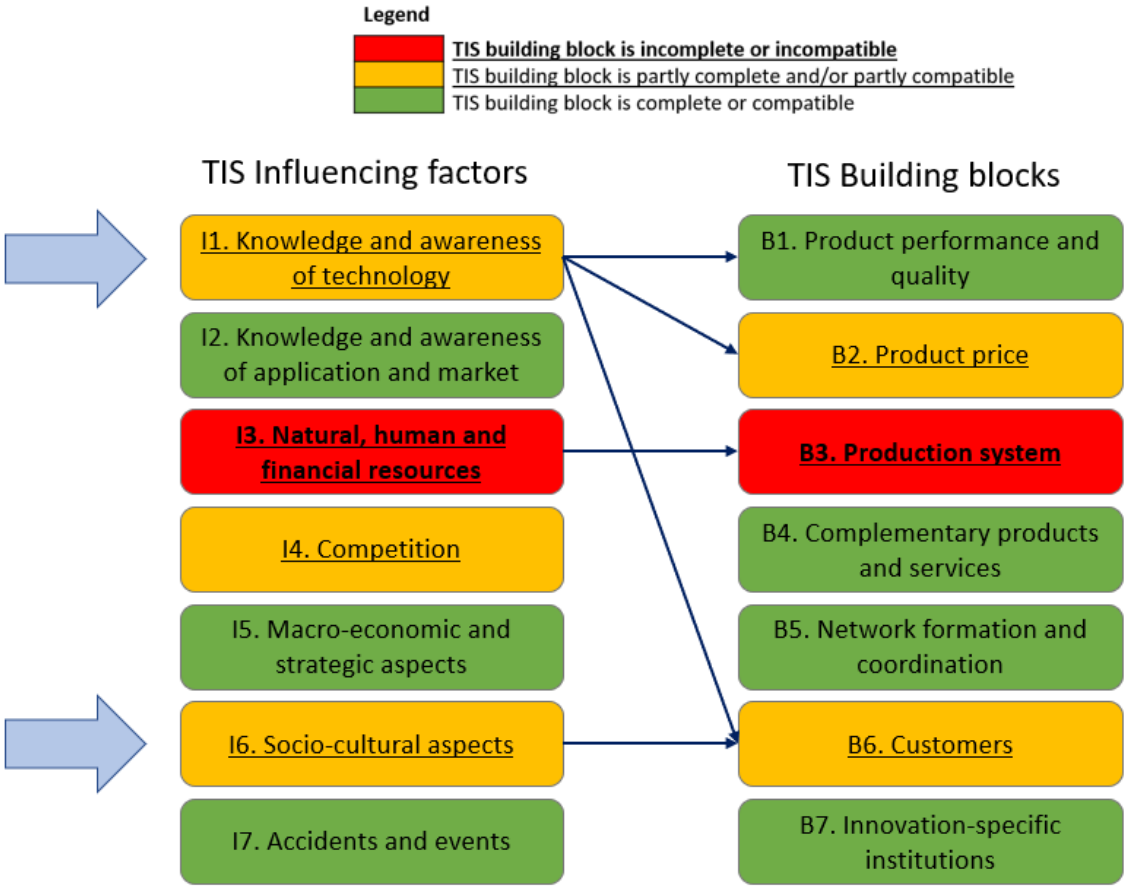


Figure 6.4 Status of TIS framework in positive case.
This figure depicts the status of the seven TIS building blocks and seven influencing factors for the THB, in case the first niche strategy outcome is positive. The legend above provides an overview of the three states and their associated formats 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.

Finally, Thermeleon can use the High-end niche strategy. Implementing this strategy would mean the startup produces to only a few highly innovative growers. Thermeleon could use the network of the Lead-user to find these growers, or find the growers who stated that 2024 would be their most lucrative year. For these grower, Thermeleon could produce their THB and integrate it specially into their greenhouses. The benefit of this strategy is that the Production System does not need to be too specialized or expensive. The THB could still be produced in batches, and integrated into the greenhouse with special attention at an additional service to the high-end users. Another benefit is that the startup would gain knowledge on how the THB can affect specialize greenhouse systems which would aid them for future sales. Additionally, through the network of these high-end growers, the startups can target more potential customers.

Negative case
In the negative case, the startup has learned from the demo and development niche strategies that the product does not work as expected. The energy reducing effect could not be as high as their desired amount of 20-30% or the THB might have some stressful effects on the plants and reduce plant quality. In this case, the status of TIS building blocks

Product Performance and Quality, and customers would become less compatible for large scale diffusion of the THB. The customers would become less compatible, since the customers are less willing to buy something that would risk their crops (Chapter 5, cultural capital).

Should this case come to pass, the next step would be to target the lacking resources and socio-cultural aspects. These could be improved using the Redesign niche strategy, Hybridization niche strategy and the Educate niche strategy. The educate niche strategy can only be used if the energy reducing quality is not high enough, not if the THB negatively affects the plant. A case could also be made for the startup to utilize the niche strategy 'explore multiple market'. However, since this study is scoped to only the Dhc sector, this strategy will not be regarded.

With the data and knowledge obtained from the experts of HortiTech and the lead user, the startup could try to redesign their first product. The product design could be focused on increasing the energy reducing effect in the greenhouse environment (e.g. by maximizing surface area per volume product, or by increasing air flow along the HeatBattery) or reducing the negative effects (e.g. different greenhouse integration location). This could therefore be increase the quality of the product for the growers and reduce the negative image for the growers.

Thermeleon can use the hybridization niche strategy to increase the value they deliver to the customer. They can do this by collaborating with other technologies or companies, such as the water buffer tanks (WOT) or a greenhouse analysis startups such as ADI. In the first example, the THB could be connected to the WOT which would increase their thermal influencing ability. This combination could reduce the energy requirements more significantly for the growers to be willing to invest. An advantage of this is that the startup can make use of the human resources of the other company to supplement their own.

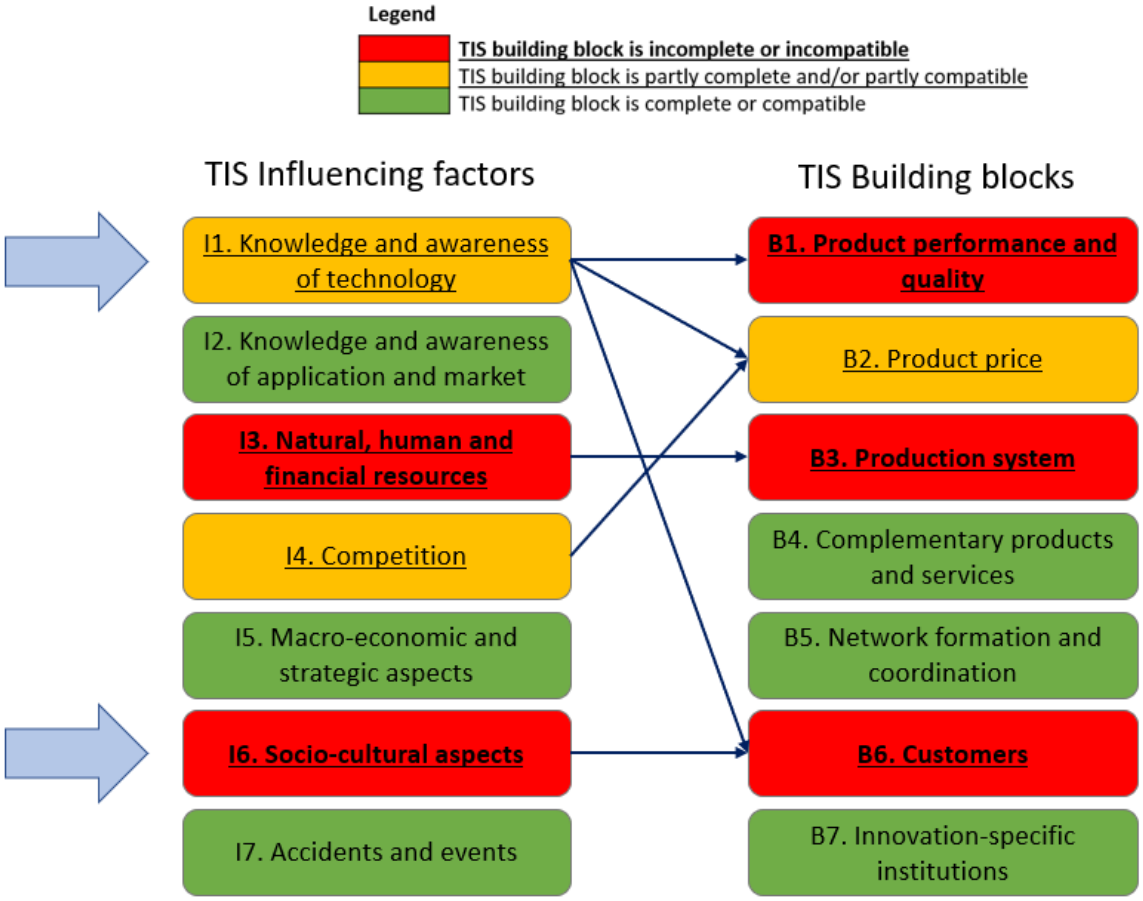


Figure 6.5 Status of the TIS framework for the THB in the negative case.
This figure depicts the status of the seven TIS building blocks and seven influencing factors for the THB, in case the first niche strategy outcome is positive. The legend above provides an overview of the three states and their 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.

Finally, the startup can make use of the Educate niche strategy, possibly combined with the Hybridization niche strategy. For this combination Thermeleon could collaborate with the analysis startup (e.g. ADI), thus making a strategic pivot and reframe their sales pitch. Instead of targeting energy reduction, they could focus on increase the heating homogeneity of the greenhouse. The analysis startup could perform a heating analysis of a greenhouse with would show the difference in temperature areas in their greenhouse over time. Since this reduces plant quality, Thermeleon could offer their THB as a means to better distribute heat across the greenhouse. For this to work, Thermeleon and the other startup could organize a campaign to educate growers on the negative effects of heat disparity in their greenhouses and then provide the solution, being the THB.

1.4 EFFECTS ON THE BUSINESS MODELS

In the previous chapter, a timeline with niche strategies was constructed as advice for the case study startup Thermeleon (Figure 11). The first step of the advice was for the startup to implement both Demo and development niche strategy and Lead-user niche strategy. In this section, we will look at how the implementation of these strategies can change the SBMC of the startup (Figure 12). First, we will look at the incomplete TIS building blocks to determine how their status might affect the up-scale-readiness of Thermeleon's SBMC. At the end of this section, a concluding summary will be given regarding the parts of Thermeleon's SBMC not ready for large scale production.

1.4.1 INCOMPLETE TIS BLOCKS AFFECTING SBMC

The four incomplete TIS building blocks of Thermeleon are, 1) the Product Performance and Quality, 2) the Product Price, 3) Production System and 4) the customers.

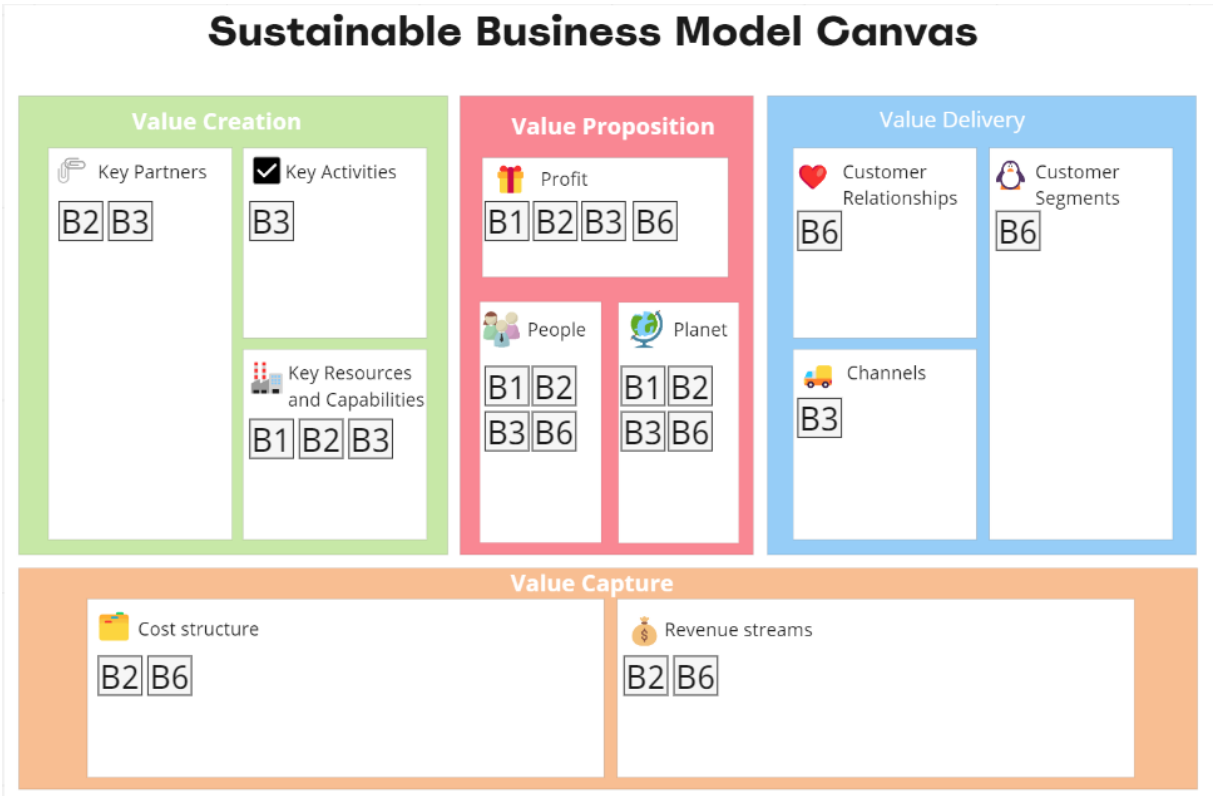


Figure 6.6 Incomplete TIS building blocks affecting SBMC

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

B1. Product Performance and Quality

In the Figure, we can see that this building block is connected to the Key Resources and Capabilities and the Value Proposition. The reason this building block is hampering large scale diffusion, is due to the fact that thermeleon is not yet capable of increasing the quality of the current MVP. Therefore, the startup should aim to gain the right people or increase their capabilities to do so. Similarly, the Value Proposition is lacking since the THB should reduce energy consumption of a greenhouse, but the startup is missing the result

to prove this on large scale. While there is such data for the small scale product, it is needed for the greenhouse scale system as well with clearly measured energy reduction.

B2. Product Price

With the incomplete production price, multiple parts of the SBMC could be lacking. Upon closer examination, the most lacking parts of the SBMC are the Key Partners, Key Resources and Capabilities, and the Value Proposition. While Thermeleon does have close relations with its Key Partners, there are some stakeholders missing that could help the startup. The startup is able to purchase the necessary resources for production for a good price, the production cost for the startup currently costs too much labor costs. As such, the startup could focus on gaining a partner capable of performing their production process, meaning that Thermeleon can outsource production to reduce the costs.
The current Key Resources and Capabilities of their SBMC is missing the right machinery for an automated production line and the capabilities to incorporate their technology to work in large scale greenhouses. The larger a greenhouse, the more complex the systems are with which the THB needs to be optimized for. The lacking part of their Value Proposition has already been discussed for at the previous building block. Little can be said for both the Cost Structure and revenue stream based on current information. The startup has not sold any THB units to other parties then their lead user Koppert Cress, thus their practical application is yet unknow.

B3. Production System

This building block is connected to most SBMC parts as the Product Price (B2). Therefore, there is no need to repeat how certain parts of the SBMC are in need of improvement. However, the additional connections of this block are the Key Activities and Channels (Figure X). Part of the Key Activities of the startup are currently focus on the production of the product. It takes too much man power to make a single unit and it takes too long. Therefore, the startup should either invest in a more automated system, or outsource it so that their Production System can improve. This will similarly, change the Channels. Either new Channels need to made for the outsourcing of production, or the distribution Channels need to be strengthened once the Production System increases in speed.

B6. Customers

Finally, the TIS block of customers. The main problem of this building block is the fact that the startup does not yet have any results prove the effect of the product. Therefore, the Value Proposition cannot be fully supplied yet. Of further importance are the Customer Relations and Customer Segments. In order to for the company to further develop, close ties with more customers are needed. Currently, the startup has great professional and personal ties with 1 grower (Koppert Cress, Lead user) and 1 installation company (Bransen Group). These have added allot of value in the form of, customer feedback and a test location. However, before the startup can increase its market presence, more such relations with multiple growers are necessary. With only 1 customer, no large scale production is possible, and little to no peer-to-peer validations will occur within the network of growers of the Dhc sector. Regarding the Customer Segments, Thermeleon has a list of characteristic for their end-user and initial Customer Segment target. This does not seem to be the lacking part. Finally, the Cost Structure revenue streams. These

have not been validated yet, since the startup has not sold to other end user (growers) yet.

Conclusion

In this section, the TIS building blocks that are nor ready for large-scale diffusion of TBH have been linked to the SBMC of Thermeleon and discussed separately. It is clear for this analysis how the TIS framework can help startups validate their BSMC. For Thermeleon, the main improvements should be the Value Proposition. This can be done by testing and further improving their THB such that the effect of the product can be clearly communicated to the growers. For this, the effect of the battery on a greenhouse system should ideally also be fully understood. Next, the Key Partners and Key Resources and Capabilities of the startup should be improved. The startup should have the right people who understand greenhouse systems and how their THB can best be implemented in them to maximize the energy saving effect. Once this is obtained, the startup can focus on improving their Customer Relations and Key Activities. The Customer Relations are a key part for the upscale possibilities of the company. As previously described, the growers of the Dhc sector have close relations with each other. The startup will need to navigate these before they can increase the diffusion of their product. The Key Activities can be more consumer and production focused once a full understanding of the TBH integration into functional greenhouses is realized.

The step-by-step explanation of the status of SBMC parts should be seen as example of how the TIS can be used to assess the SBMC of a startup. Knowing what parts of a SBMC are lacking, shows what the startup should focus on improving. Means to improve those lacking or incomplete SBMCs are the niche strategies.

1.4.2 NICHE STRATEGIES AFFECTING SBMC

This study proposed that Thermeleon should use the demo development niche strategy with the lead user niche strategy to improve the status of their TIS building blocks (Figure 6.7) and the SBMC (Figure 6.8).

Depending on the specific implementation of the niche strategies, building blocks B1, B5 and B6 can be improved (Figure 6.7). Following the advised overarching strategy (Subchapter 6.3.1), the main focus for improvement are building B1 Product Performance and Quality and B6 Customers. The functionality of the THB and its integration into functional greenhouses will need to be tested and developed using the proposed strategies. Once that is done, then the startup can start to increase the Customers (B6) block, by increasing customer relations.

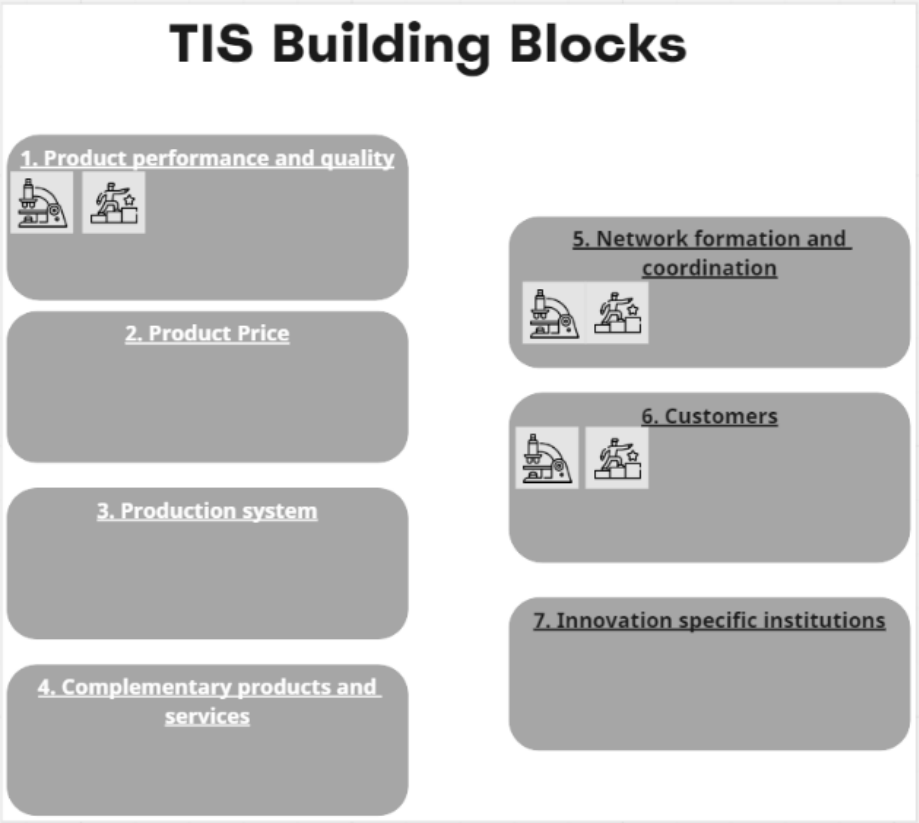


Figure 6.7 Effects of niche strategies on the TIS building blocks

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.

The niche strategies can also improve the SBMC (Figure 6.8), based on the lacking TIS building blocks and their connection to the SBMC (Figure 6.6). Using this connection we can see what parts of the SBMC need improvements. The niche strategies are formulated to improve those parts. The Demo and development niche strategy should be used to improve the Value Proposition of the product. The strategy will need a new and stronger connection to the Key Stakeholder where the demo testing can take place. The Lead-user niche should improve the Key Partners, and Customers Relationships with the chosen Customer Segments.

Aside from these targeted improvements, other parts of the SBMC can be altered by the niche strategies. Namely, with a closer relation to the demo testing facility Hortitech, new Channels to customers can be opened by utilizing the network of HortiTech. The Channels to the customers can also be extended through the Lead-user strategy and the Key Activities can become more focused on the improvements and integration of the product.

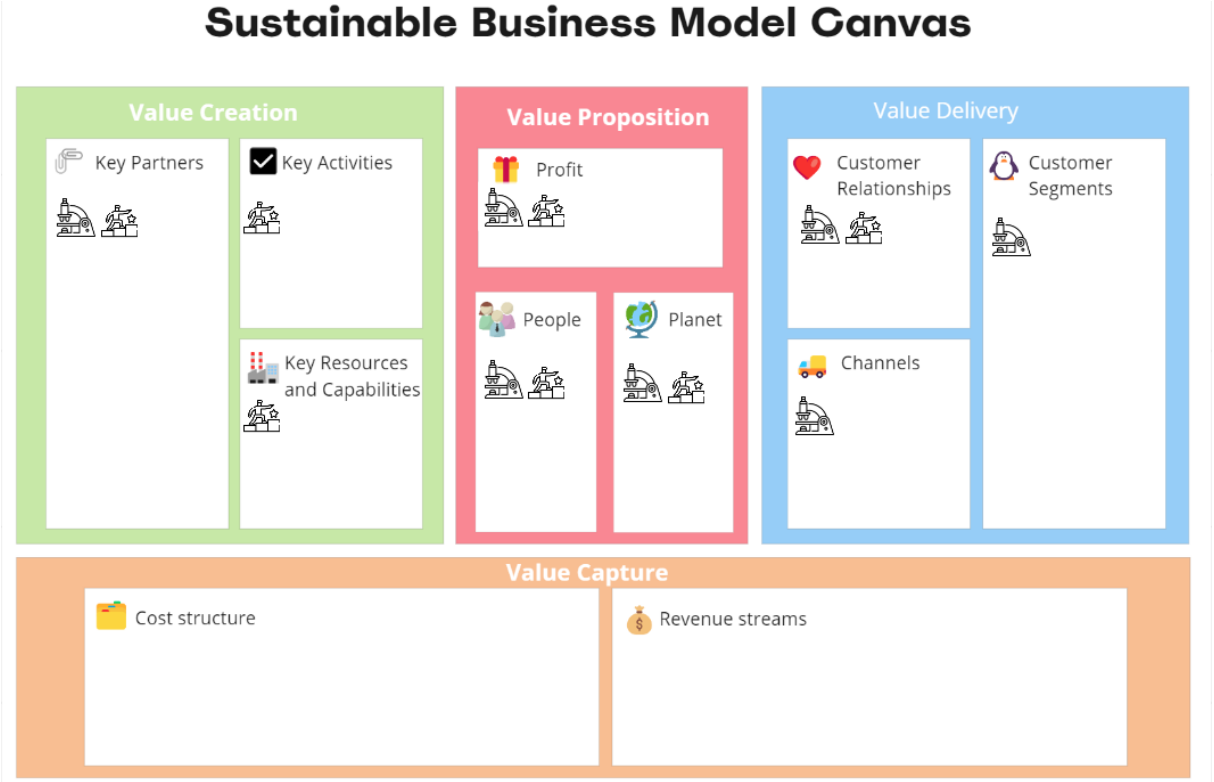


Figure 6.8 Effects of niche strategies on the SBMC

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.

2. APPENDIX

Table A1. Connection between TIS building blocks and SBMC blocks

TIS building block	**SBMC block**
Product performance and quality	(Value Proposition) Profit (Value Proposition) People (Value Proposition) Planet
Product price	Key Resources and Capabilities (Value Proposition) Profit (Value Proposition) Planet Cost structure Revenue streams
Production system	Key Stakeholders Key Activities Key Resources and capabilities (Value Proposition) Profit (Value Proposition) Planet
Complementary products and services	Key activities (Value Proposition) Profit Channels
Network formation and coordination	Key stakeholders (Value Proposition) People Customer Relations Channels Cost structure Revenue streams
Customers	(Value Proposition) People Customer Relations Customer segments Revenue streams
Innovation-specific institutions	Key stakeholders

Table A2. Description of the effects of niche strategies on the TIS building blocks and SBMC

Generic niche strategies	**Effect on TIS building blocks**	**Effect on SBMC**
1 Demo, experiment and develop niche strategy	· Product performance and quality · Network formation and coordination · Customers	· Key Stakeholders · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Relationships · Customer Segments · Channels
2 Redesign niche strategy	· Product performance and quality · Product price · Production system · Complementary products and services · Customers	· Key Activities · Key Resources and Capabilities · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Segments · Cost Structure · Revenue streams
3. Stand-alone niche strategy	· Complementary products and services	· Key Activities · Key Resources and Capabilities · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Relationships · Customer Segments
4. Hybridization or adaptor niche strategy	· Product performance and quality · Product price · Production system · Complementary products and services · Network formation and coordination · Customers	· Key Stakeholders · Key Activities · Key Resources and Capabilities · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Segments · Channels · Cost Structure · Revenue streams
5. High-end niche strategy	· Product performance and quality · Product price · Production system · Customers	· 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	· Complementary products and services · Customers	· Key Activities · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Relationships · Customer Segments · Channels
7. Lead user niche strategy	· Product performance and quality · Network formation and coordination · Customers	· Key Stakeholders · Key Activities · Key Resources and Capabilities · Customer Relationships · Customer Segments · Channels
8. Explore multiple markets niche strategy	· Product performance and quality · Network formation and coordination · Customers	· Key Stakeholders · Key Activities · Value Proposition – Profit · Value Proposition – People · Value Proposition – Planet · Customer Relationships · Customer Segments · Channels
9. Subsidized niche strategy	· Product price	· Value Proposition – Profit · Cost Structure
10. Geographic niche strategy	· Complementary products and services · Network formation and coordination · Innovation-specific institutions	· Key Stakeholders · Key Activities · Channels · Cost Structure · Revenue streams