1. CASE STUDY STARTUP | FOTONIQ

Similar to the previous chapter, the theory and findings of the previous chapters will be applied to a sustainable startup in the Dhc, namely FOTONIQ. The TIS framework will be applied similarly such that niche strategies can be determined and described Finally the effect of the niche strategies on the SBMC and TIS building blocks will be theorized. The startup will first be introduced and their business model described.

1.1 FOTONIQ

The startup by the name of FOTONIQ officially started in January 2023. However, the product they make for the Dhc, PAR+, has been developed by PHYSEE since 2017. PAR+ is a special coating which, once applied to windows, optimizes light condition in the greenhouse. If applied to the windows of a greenhouse, improved light conditions can be obtained for the plants from the natural solar light. This would reduce the need for additional lighting inside the greenhouse and optimize the use of naturally resourced. An additional function of the coating is to diffusive the incoming light. Diffuse lighting has been shown to increase plant production as the light hit more surface area of the plant. Therefore, the PAR+ coating bests fits the 'maximize material and energy efficiency' archetype of the technological grouping, when referring to the 9 sustainable business model archetypes of 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

The status of the building blocks of the startups were discussed with the co-founder and Business Developer of FOTONIQ. The status of each building block will be described individually. This section will end by providing a visual overview of the status of all building blocks (Figure 1).

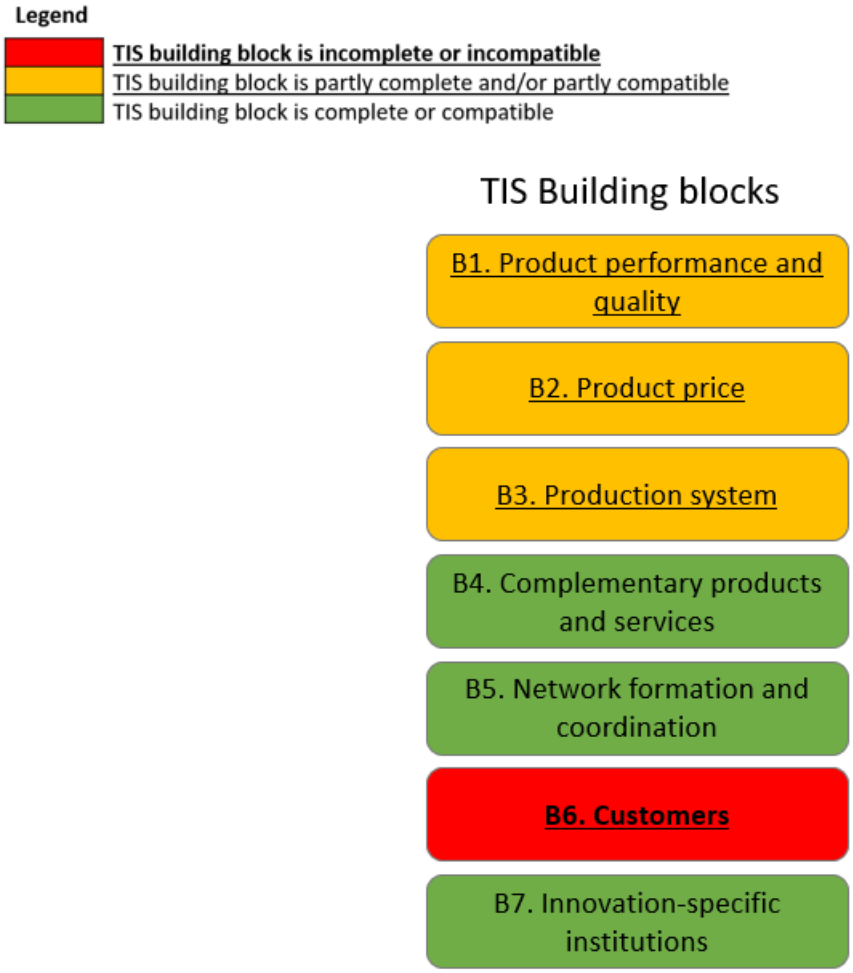


Figure 1. *Status of the TIS building block for the PAR+ coating by FOTONIQ.*

1.2.2 STATUS OF THE INFLUENCING FACTORS

Following the TIS building blocks, we will assess the influencing factors of FOTONIQ. The effects of the influencing factors on the building blocks will be described as well (Figure 2).

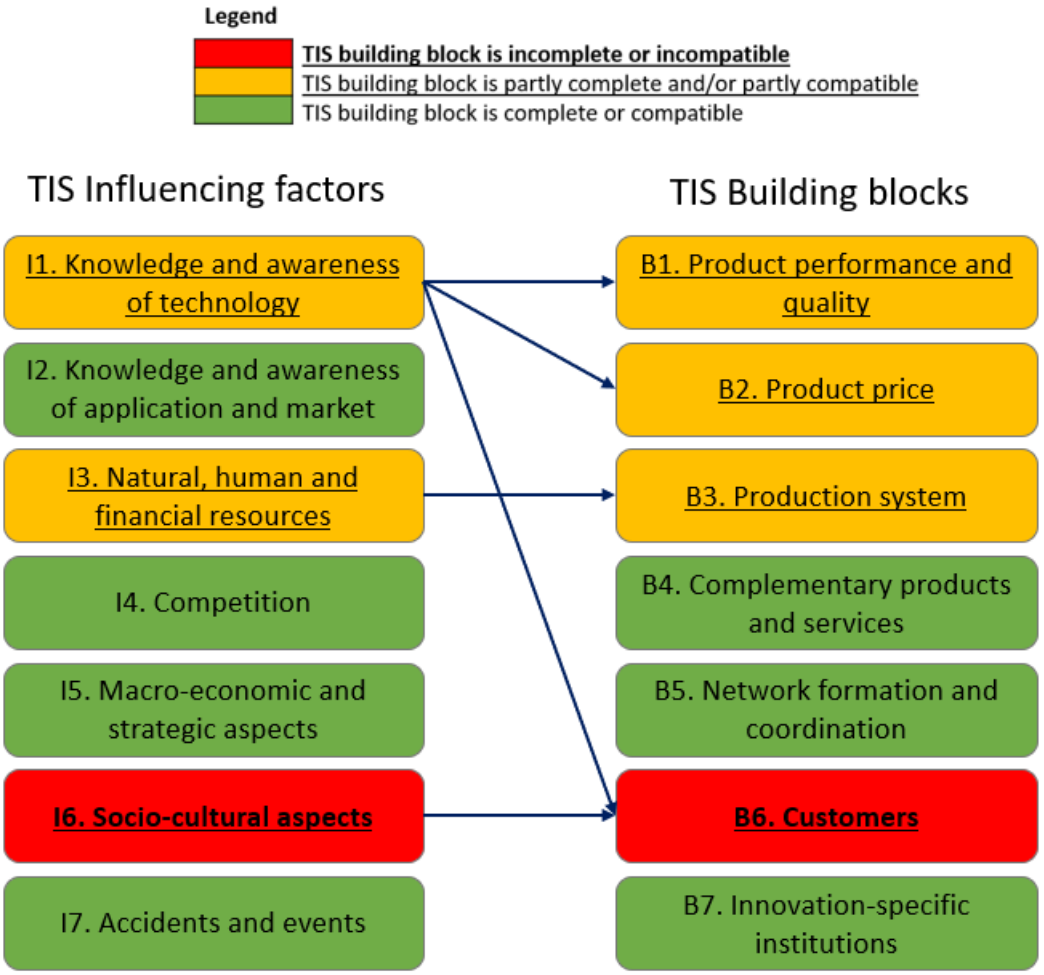


Figure 2. *Status of the TIS influencing factors affecting the TIS building block for the PAR+ coating by FOTONIQ.*

1.3 NICHE STRATEGIES TARGETING TIS BARRIERS

Now that the TIS building blocks and influencing factors have been assessed, appropriate niche strategies can be formulated using according to TABLE X (Ortt et al., 2013). This study will aim to formulating a strategy specific to the start and their current situation using the 10 possible niche strategies described by Ortt et al., (2013). Based on the TIS framework, the following strategies could be used (Table 8).

Table 1. *Appropriate niche strategies possible for FOTONIQ based on TIS.*

Generic niche strategies	**Description of the niche strategy**	**Implement based on TIS situation FOTONIQ**
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)
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) • Hindering Socio-cultural aspects (I6) affect the availability of Customers (B6)
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 quality (B1)and Product price (B2)
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 Customers (B6)

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.	• Hindering Socio-cultural (I6), affect Customers (B6).
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) •Lacking Resources (I3) affects the Production system (B3)
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.	• Resources (I3) affect Product quality (B1) • Hindering Socio-cultural (I6) affect Customers (B6)

These strategies can be implemented in a multitude of ways depending on the specific situation of the company. Therefore, this study will formulate a potential strategy based on the current situation of FOTONIQ (Table 1).

1.3.1 OVERARCHING STRATEGIC ADVISE FOTONIQ

In this section, an overarching strategy will be described for FOTONIQ. This strategy will combine multiple niche strategies and formulate multiple possible cases with outcome into a timeline (Figure 3). The main hindering influencing factor and building block will be targeted first. The biggest hindering factor for FOTONIQ is the socio-cultural aspect which affect the willingness of the customers to invest and try their coating. To address this, the main niche strategy should be aimed at improving the status of the customers building block by leveraging the positive effect of the cultural system of the sector. The Lead-user, Redesign, or Geographic niche strategies could be useful in this regard.

In addition to socio-cultural effects, lack of knowledge of the technology is another hindering factor that affects the Product performance and quality, Product price and Customer building blocks. The key missing knowledge is data regarding the optimal functioning of the coating for eight years and the changes to greenhouse systems required to make optimal use of the coating. This information is especially important because it provides growers with insights into new cultivation methods based on the innovation.

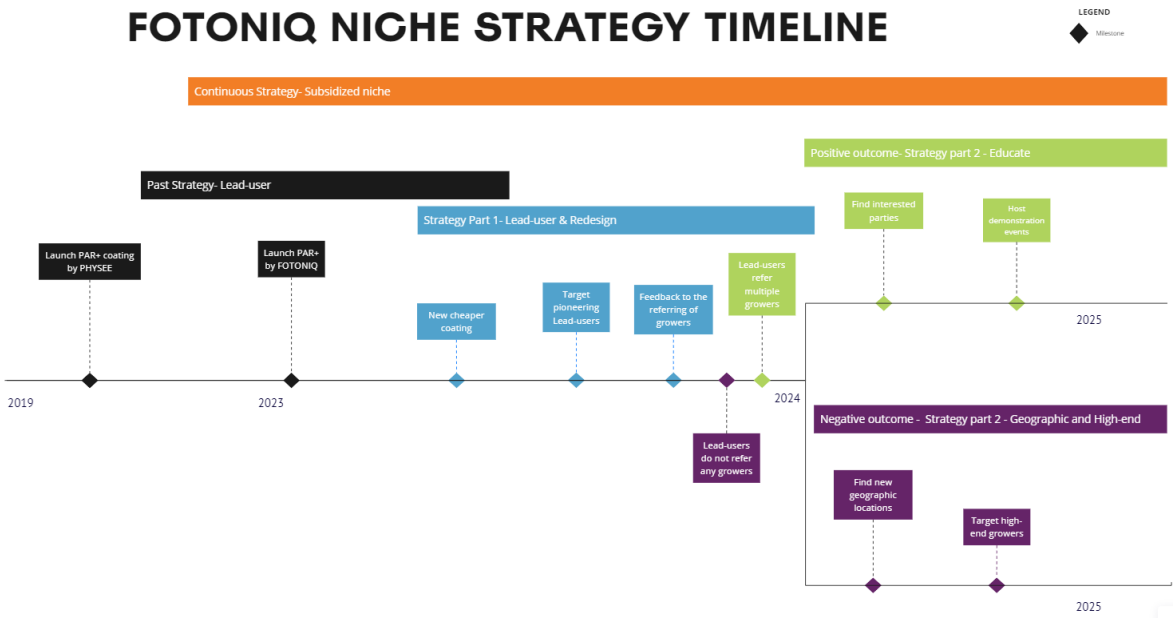


Figure 3. Timeline for the niche strategies of FOTONIQ

Based on the most significant hindering factor, three potential niche strategies are available for FOTONIQ. However, this study recommends a combined strategy based on the Lead-user niche and Redesign strategy. The Lead-user strategy targets customers, taking socio-cultural aspects into account, to work in FOTONIQ's favor. The Redesign niche strategy targets customers through both socio-cultural aspects and technology knowledge influencing factors. By creating a new product with lower costs and a shorter duration for the coating to remain on the greenhouse, the perceived risk for growers is reduced.

The primary goal of the Redesign niche strategy should be to reduce production costs for FOTONIQ and shorten the duration of the coating's application. A coating that is removed after one or two years, is a lower risk than a coating that promises to stay on the greenhouse for eight years especially if the coating does not function as well as intended for the promised product lifetime. As stated in Chapter 5, growers need to 'feel' the effect of a new innovation in their greenhouse such as humidity, production, and environmental factors, before they trust it. FOTONIQ can start building that trust by introducing a product that is similar to what growers are currently familiar with (chalk coating), which only stays for a single season. Once the trust is gained from a certain number of growers, FOTONIQ can introduce new versions of the coating that stay for longer periods, such as their current product. Growers who believe in the coating can then invest in the version that stays for eight years, while new customers can try the product type that stays for fewer years. During the workshop with the startup, it was noted that FOTONIQ can already produce a coating with a product lifetime of four years instead of eight, which is a good alternative for the Redesign niche.

The new product should be specifically targeted to specific Lead-user growers. The growers in the Dhc are often in close connection, with collaborations and other business

relationships between them to promote functioning innovations and cultivation techniques. Within those communities, there will be growers who hold a strong reputation. FOTONIQ should target those growers to increase the reputation of the PAR+ coating among the growers of that community. Additional targets could be growers' associations, such as Harvest House of The Greenery, which have multiple growers working with them. During the workshop, the startup mentioned how growers are hesitant to invest in the innovation. It takes a lot of effort for the startup to convince growers to try the coating, even with the acknowledgment from other growers of a different crop or greenhouse design. The study suggests a different approach within the same niche strategy by incentivizing the Lead-users to promote the PAR+ coating to their close contacts of growers. FOTONIQ should target one grower for each crop type or region of their customer segments as a Lead-user. These Lead-users should receive the coating for free or at a high discount, depending on the financial ability of the startup, with the condition that they promote the coating to other growers in their network. The contract should stipulate how the lead-user will gain additional financial benefits for each grower they refer to FOTONIQ. This approach would motivate the Lead-users to actively participate in word-of-mouth marketing, reducing the time and effort FOTONIQ needs to spend on convincing new growers.

The down side of this strategy is reduced income. Not only will the startup take additional risks for the first Lead-User of a target customer segment, but the financial return for each new customer referred by the Lead-user will be also lower. As such, the implementation of this niche strategy can lead to either positive or negative outcomes. In the positive case, this investment will not only increase the number of customers through socio-cultural aspects but also increase the knowledge of the technology due to the constant application and implementation of the product to the new customer base. In the negative case, the referring is not working as hoped. Therefore, it's important to consider both the potential positive and negative outcomes of this strategy.

Positive case

If the growers are more accepting of a coating with a shorter product lifetime, and the Lead-user strategy leads to a more positive outlook from the sector and customers to the coating, it would be a great success for FOTONIQ (Figure 4). The positive response of the growers to the product will increase the socio-cultural aspect of the sector towards the startup. As the effect of the coating on production is felt by the growers and the lower costs reduce the threshold for the growers to switch to the new coating, the adoption rate of the PAR+ coating would increase among growers. The increase in implementation of the product into new and other greenhouses would lead to a better understanding of how the coating might affect cultivation methods, and FOTONIQ would gain new insights they can provide their customers on how they could optimize their greenhouse systems to maximize the effect of the coating.

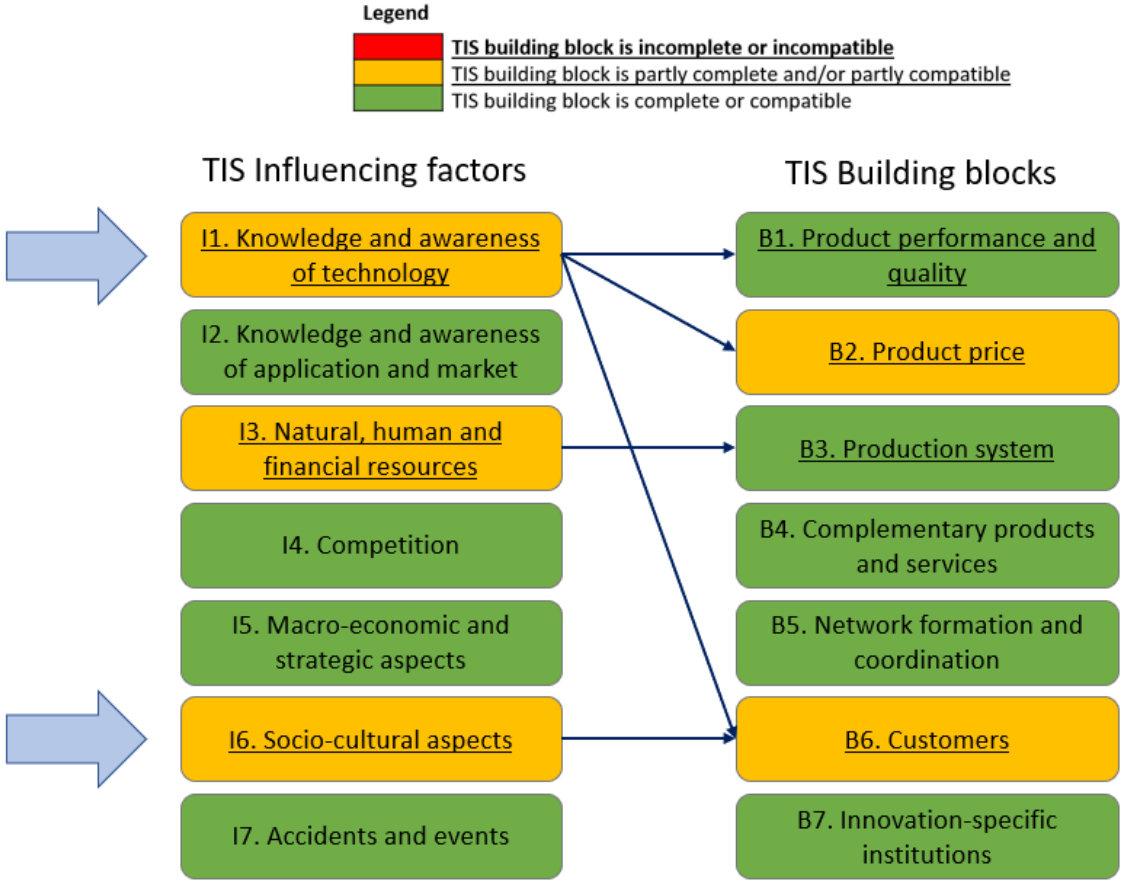


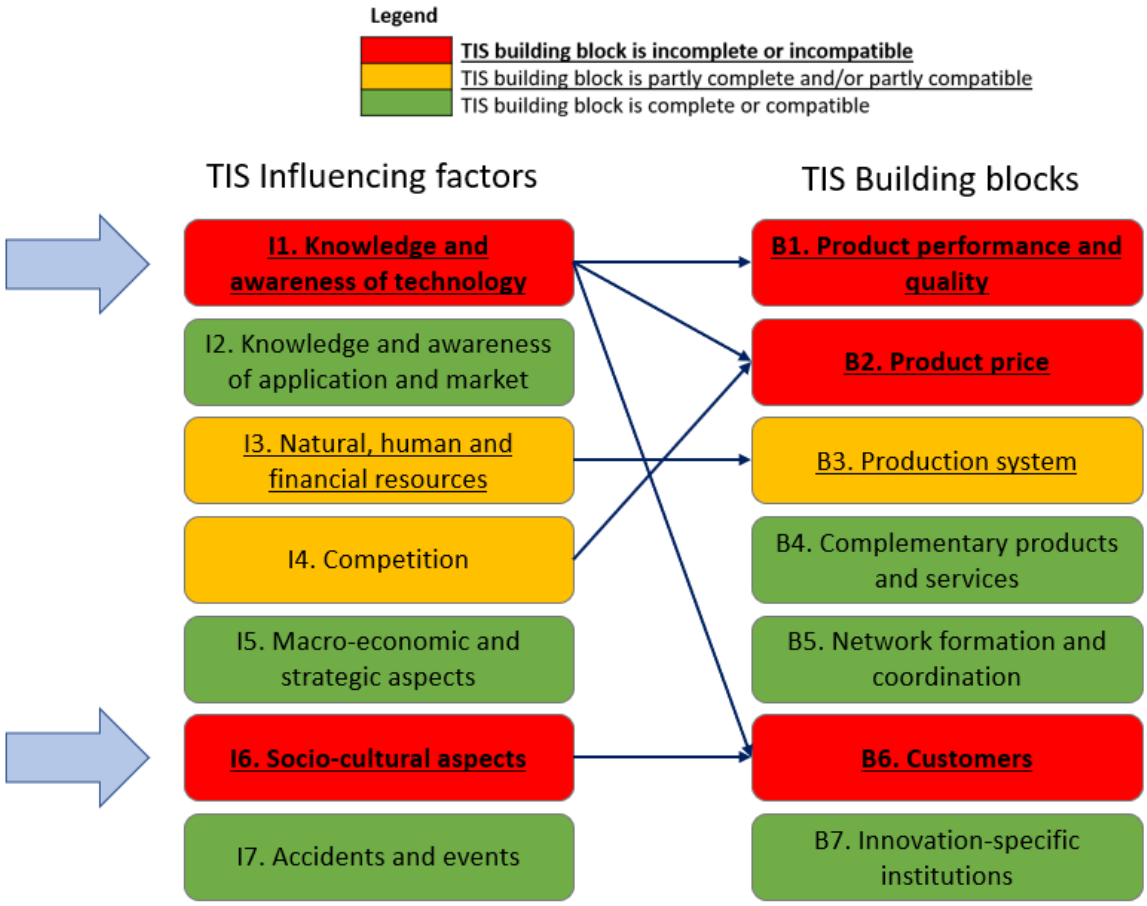
Figure 4. Status of the TIS factors for FOTONIQ in the positive case.
The blue arrows depict the effects of the Lead-user and Redesign niche strategy.

If this situation comes to pass , FOTONIQ should find a new niche strategy based on the most hindering influencing factor to further improve their company's status based on the TIS framework. In this situation, the main hindering factor in this situation is the knowledge and awareness of customers, as not all growers believe in the positive effect of diffuse light on the product. Therefore, this study suggest the implementation of the Educate niche strategy, to increase the adoption of their coating by the Dhc.

The Dhc currently has numerous institutions focused on gaining understanding in the best practices, or optimal greenhouse systems collaboration to maximize effectiveness of greenhouse cultivation in the Netherlands (Chapter X). FOTONIQ could leverage the data obtained from their Lead-User customers to showcase the positive effect the coating has on production to these institutions. Along with these institutions, FOTONIQ should target larger growers who do not believe in the diffuse effect to educate them on the proven effect based on their findings in functional greenhouses. FOTONIQ might also combine this with the Geographic niche and educate growers in other geographic sectors who wish to improve their greenhouse cultivation efficiency such as Morocco or Scandinavian countries.

Negative case

In the worst-case scenario, FOTONIQ's combined Lead-user and Redesign niche strategies do not generate the desired results. This could happen if growers are not interested in promoting the PAR+ coating, or if the promotional efforts are ineffective, leading to little



to no

Figure 5. Status of the TIS factors for FOTONIQ in the negative case.
The blue arrows depict the effects of the Lead-user and Redesign niche strategy.

increase in sales. This could be due to a lack of belief in the positive effects of the coating, or the product's price being perceived as too high compared to its functional quality, meaning the expected increase in production for Lead-users is lower than the cost of the coating. As a result, the products of the competitors would be seen as better received in the minds of the growers, and the relative price of the PAR+ coating would be perceived higher as a result (Figure 5).

If this happens, the main barrier would be the socio-cultural aspects of the Dutch horticultural sector and the growers' lack of knowledge and understanding of the product. In this case, the best remaining strategy would be to implement a Geographic niche. This study also suggests, to combined that with a High-end niche strategy.

For the geographic niche, FOTONIQ could focus on countries that are heavily invested in increasing their domestic food production due to various reasons. For example, due to the war in Ukraine, the country has been unable to export as much food to other European countries, resulting in an increasing demand for domestically sourced food. Additionally, China and America are also investing in increasing their domestic food

production efficiency. By targeting these countries, FOTONIQ can overcome the socio-cultural barriers of the Dhc and increase its potential customer base.

For these new geographic markets, FOTONIQ should focus on high-end growers who are willing to pay more for the latest greenhouse innovations. FOTONIQ can offer personalized optimization of greenhouse systems to maximize the utility of the coating and its effect on production efficiency. This approach will position FOTONIQ as a company that provides top-of-the-line products while also gaining knowledge and understanding about how greenhouse systems can be altered to maximize utility. The downside of this strategy however, is that new networks of stakeholders need to be formed to make such operations possible in other countries.

1.4 EFFECTS ON THE BUSINESS MODELS

In the previous chapter, we described company-specific niche strategies for FOTONIQ based on the current TIS status and visualized them into a timeline (Figure 3). The initial advice was for the startup to implement both Lead-user and Redesign niche strategies. In this section, we will explore how the implementation of these strategies can alter the SBMC of the startup (Figure 6). To begin, we will examine the incomplete TIS building blocks to assess how their status could impact the up-scale-readiness of FOTONIQ's SBMC. At the end of this section, a concluding summary will be given regarding the parts of FOTONIQ's SBMC not ready for large scale production.

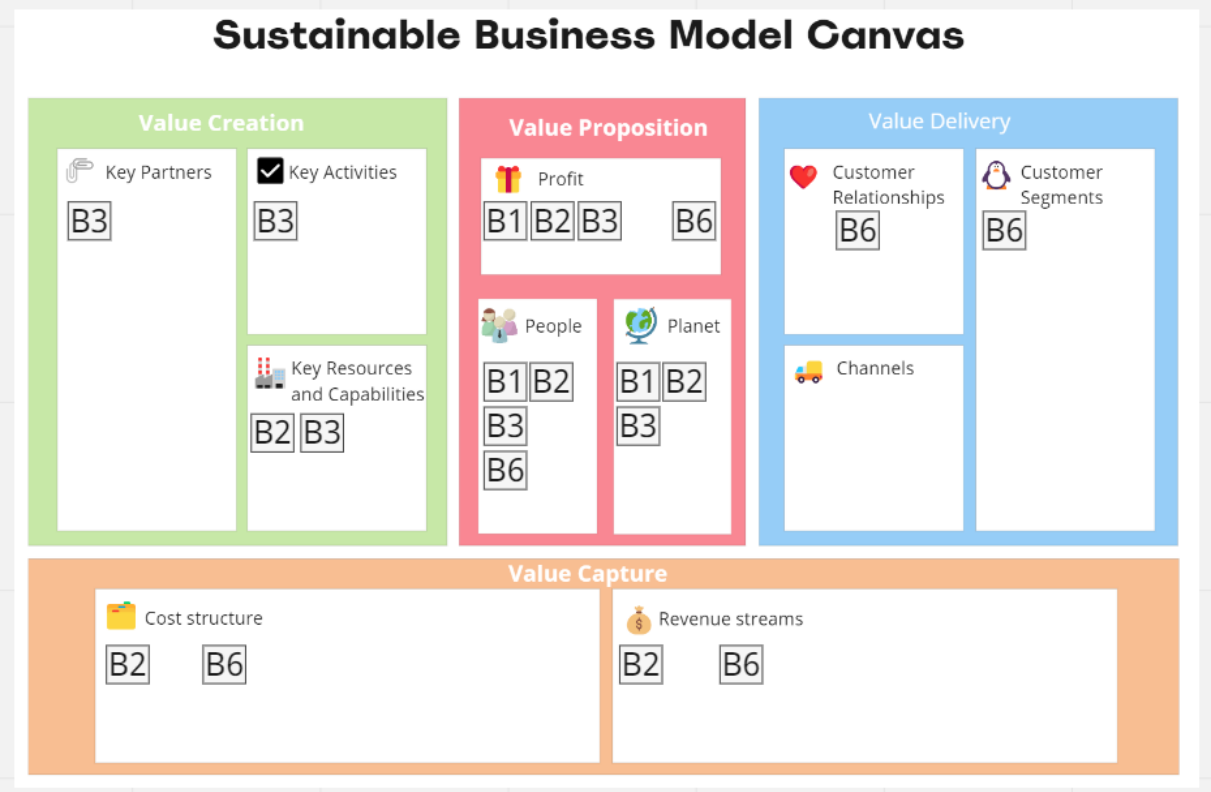


Figure 6. Sustainable Business Model Canvas with market building block B1, B2, B3 and B6.
The boxes depict the 4 building blocks which are incomplete for FOTONIQ. The locations of the boxes indicate how the various incomplete building blocks are connected to the SBMC

1.4.1 INCOMPLETE TIS BLOCKS AFFECTING SBMC

B1. Product performance and quality

It is evident from Figure 6, that if the first TIS building block (B1) is lacking, FOTONIQ's value proposition will not be ready for large-scale diffusion. The startup's value proposition entails supplying a specific coating that refracts natural light to more PAR dense and diffuse light for greenhouses, which can remain functional for eight years. Although this value proposition seems promising, there is a missing link, namely a clear method to maximize production increase by optimizing greenhouse systems to the new coating and sufficient proof for growers that the coating will remain functional over the eight years. Without this missing link, the value proposition may not be compelling enough for growers to adopt the product on a large scale. Therefore, it is crucial for FOTONIQ to focus on developing this aspect of their value proposition to ensure up-scale-readiness of their SBMC.

B2. Product price

During the workshop with FOTONIQ, it became evident that the price of the product is competitive compared to that of its competitors. However, the main issue lies in the lack of trust from the growers in the startup's value proposition. Growers are uncertain about the return on investment from using the coating, and the startup is uncertain about how taxation will be handled. These issues need to be addressed in order to increase trust and adoption of the product among growers.

B3. Production system

FOTONIQ claimed that their building block is complete since they can set up a large-scale production process as soon as the startup has enough sales to warrant such a production system. However, for this study, we assessed the status of the building blocks based on their current performance, not the ease of upscaling. Therefore, we evaluated this building block as partly incomplete. This status can also be correlated with the SBMC parts shown in Table A1, which indicates that the Key Activities and Key Resources and Capabilities are lacking based on the incomplete TIS building block.

Currently, the Key Activities of the startup mostly focus on R&D, business development, and sales. Production or increasing production capacity is not the main priority of the company. As FOTONIQ stated, the startup does not have enough resources to finance a production system large enough to fully distribute their coating across the Dhc. Therefore, these parts of their business model need to be addressed before the startup can upscale their production.

B6. Customers

The final TIS building block that is unready for large scale production is the Customers block. As previously mentioned, this is due to growers' hesitation towards the coating and its longevity. However, the connection between this building block and the SBMC has not been fully discussed yet. The missing link can be found in the Value proposition, Customer relations, Customer segments, or Revenue streams (Table A1).

The issue with the Value proposition has already been discussed in previous parts. The Customer Relations are incomplete due to a lack of trust within grower communities, which hinders the growth of the startup. While FOTONIQ has close relations with a few growers to whom they supplied their coating, they do not have similar ties with leading growers in other communities of their target customer segments. As a result, FOTONIQ needs to spend more time and effort in sales to gain new customers, rather than leveraging the close ties of their current customers to gain support of new customer segments and relations.

To address this issue, the startup should aim to improve the number and strength of relationships it has with growers, especially those who have a strong reputation within their respective communities based on the crops or regions they are in. This can help to build trust and credibility for FOTONIQ among potential customers, leading to greater adoption and diffusion of their coating technology.

Conclusion

In this section, the TIS building blocks that are not ready for large-scale diffusion of the PAR+ coating have been linked to the SBMC and discussed. It is clear from this analysis how the TIS framework can function as a means to test the SBMC of a startup and its readiness for upscaling. For FOTONIQ, it can be stated that their main focus should be on improving their Value Proposition and Customer Relations. The Value Proposition can be

improved by finding effective ways to communicate to the growers how their coating will improve production efficiency for the entire product lifetime. Additionally, FOTONIQ should aim to increase the number of growers they have business relations with and strengthen the ties they have with them. The startup needs to gain a foothold in the grower communities through their Customer Relations and establish a certain level of trust, so that their Value Proposition can be communicated with less hesitation or scrutiny.

Aside from these as the main focus, FOTONIQ should also try to improve the status of their Cost Structure, Key Activities, and Key Resources and Capabilities. For the Cost Structure, it is important that the taxation of their product is clear for the grower. The Key Activities should include tasks that increase production capacity the moment the startup chooses to upscale, and the Key Resources and Capabilities should be able to manage the increasing demands that upscaling of production capacity demands.

1.4.1 NICHE STRATEGIES AFFECTING TIS AND SBMC

This study proposed that FOTONIQ should implement a Redesign and Lead-user niche strategy. The implementation of these strategies can improve the status of both the TIS building blocks (Figure7) and the SBMC (Figure 8).

Depending on the specific implementation of the niche strategies, building blocks B1 to B6 can all be improved. However, based on the description of the strategy, the main focus for improvement will be on building blocks; B1 Product performance and quality, B2 product price and B6 Customers. The PAR+ coating will need to be altered such that the coating will perform for a shorter period and for a cheaper price. The customers will need to be gained by forming close relations with the Lead-user who will get benefits from providing FOTONIQ with more potential customers.

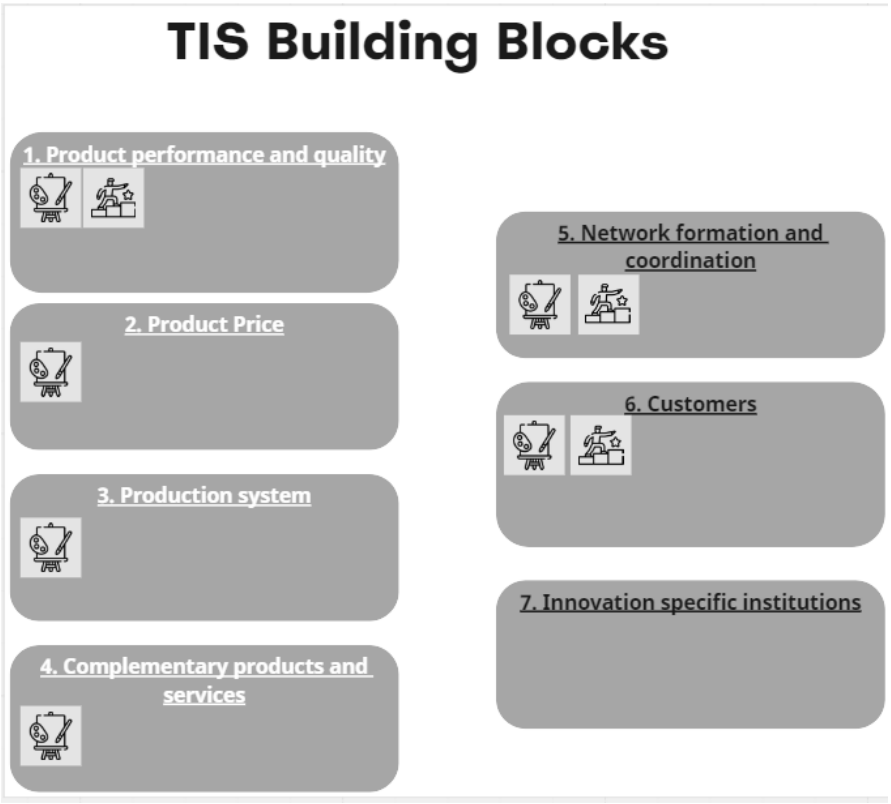


Figure 7. Niche strategies affecting TIS building blocks.
The icons for Lead-user and Redesign niche strategies are depicted in the TIS building blocks which indicate how the various niche strategies can improve the TIS building blocks.

The niche strategies can also improve the SBMC (Figure 8). Based on the lacking TIS building blocks and their connection to the SBMC (Figure 6), we can see what parts of the SBMC need more attention. Similarly, the niche strategies are chosen such that those are targeted. Namely, the Redesign niche should aim to improve the Value Proposition of the coating to the grower. Additionally, Lead-user niche should improve the Key Stakeholders, 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 cheaper product price, the Cost Structure and Revenue streams will be different. The Channels to the customers can be more defined through the Lead-user strategy and the Key Activities can become more production focused as the sales and customer size increase.

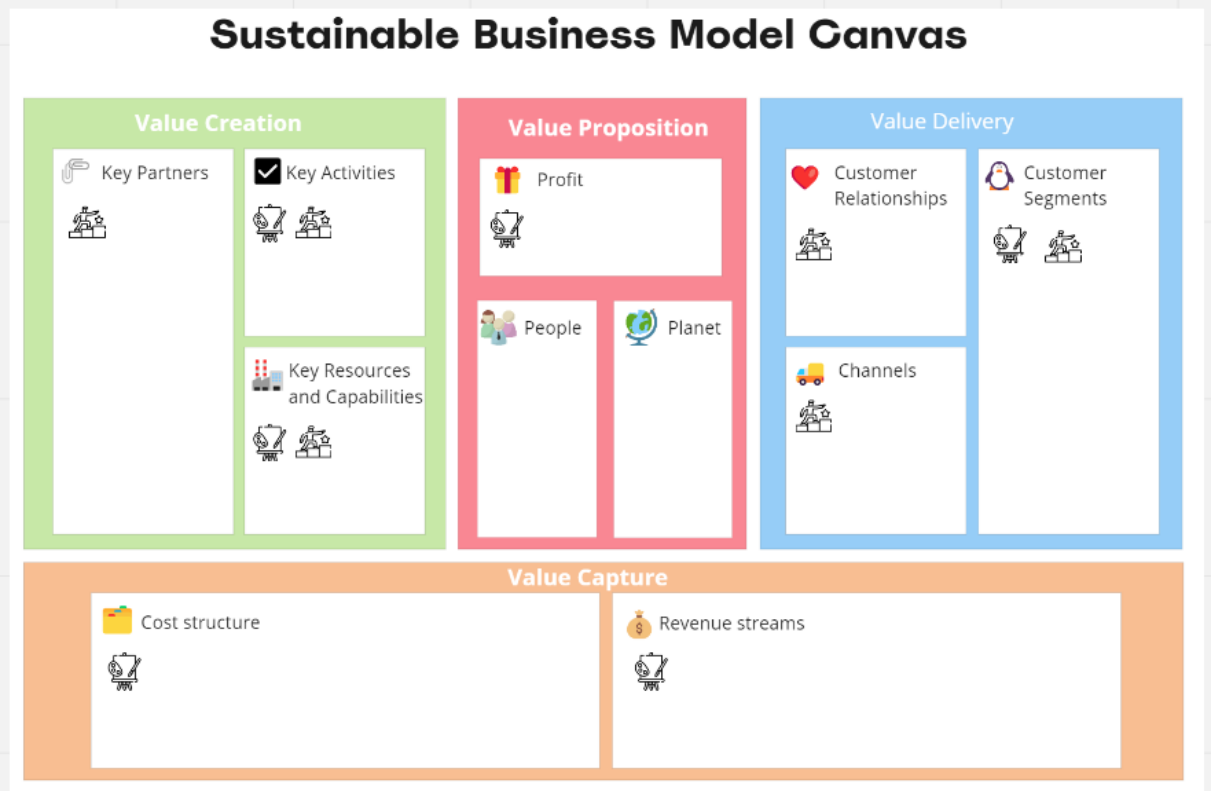


Figure 8. Sustainable Business Model Canvas with marked niche strategies.
The icons for Lead-user and Redesign niche strategies are depicted in the SBMC which indicate how the various niche strategies can improve the SBMC.

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
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

3. DETAILED DESCRIPTION OF THE TIS FRAMEWORK

Product performance and quality:

Par plus coating has shown to have high quality in the laboratory setting, with a high diffusivity effect while losing minimal to no light. The coating has also been reported to increase the density of Par light from sunlight, leading to an overall increase in effective light coming into the greenhouse. These qualities make Par plus coating an attractive option for greenhouse growers.

Unfortunately, there are some hindering factors in regards to the products' performance and quality. FOTONIQ states that the PAR+ coating is able to stay on the greenhouse windows for 8 years. This duration is much longer than other coating currently provided to the sector. While this should make the PAR+ coating more attractive to growers in theory, in practice this is not the case. The growers are hesitant to accept a new product from a relatively young company, that a coating with would remain on their greenhouse for so much longer than current known and trusted coatings, especially without the endorsement of their peers. Should the coating reduce in effectiveness sooner than the promised 8 years, chances are the grower will suffer a loss. Either due to the higher cost of the coating, or reduced plant production due to reduced diffusivity or light refraction effect of the coating. Since FOTONIQ does not have any field tested results of their product over an 8 year period, the startup is not able to effectively remove de doubts of the grower.

Another concern for growers is the lack of information on how to incorporate the PAR+ coating into their cultivation methods. Some growers may not fully understand the positive effects of diffusivity or may not know how to make the most of the changes in light wavelength density that the coating can bring.

As such, we can conclude that the quality and performance of PAR+ is not yet compatible with large scale diffusion. While the product shows great results on small scale, there are concerns that make it incompatible for large-scale production. More data and information are needed to address these issues and to provide growers with the necessary information to make informed decisions about incorporating the product into their cultivation methods.

Product price

The PAR+ coating has several positive aspects in terms of its product price. From the client's perspective, the PAR+ coating should be cheaper overall when compared to competitors, especially when compared to the current coating methods used in greenhouses, such as the chalk coating. While the initial cost of PAR+ coating may be more expensive, the coating is able to stay on the greenhouse for up to 8 years, making the yearly cost of PAR+ coating less when compared to other coatings that need to be removed and reapplied after each winter season. Furthermore, the companies responsible for the application and removal of other coatings can just as easily apply and remove the PAR+ coating for the growers. Since the PAR+ coating needs to be applied and removed only once in 8 years instead of yearly, the relative 'price' for a grower to switch

coatings is actually negative, meaning the costs of application and removal are lower compared to other types of coating.
However, there is a negative aspect to the product price of PAR+ coating. The depreciation of the coating is not yet determined, and it is unclear if tax bureaus will agree that a coating which 'should' stay for 8 years can be marketed in the bookings as an 8-year investment with yearly depreciation. This uncertainty could affect the tax prices and may make it less attractive for some growers.

In conclusion, the product price of PAR plus coating is partly compatible for large-scale production. While it may be more expensive initially, the long-term cost-effectiveness and added benefits make it an attractive option. However, the uncertainty in regards to the depreciation needs to be resolved to make it a more viable option for growers.

Production system

Regarding the production system, the startup has all the necessary knowledge and skill, to create a good production line. During the workshop was stated, the moment they get 20+ sales with payments upfront, they are able to setup fully their production capacity. However, the startup currently does not have the financial resources nor clientele to do so. Considering this situation the production system was considered to not fully compatible for large-scale production.

Complementary products and services

For FOTONIQ there are multiple complementary products and services to make use of. As mentioned, there are multiple companies that apply and remove the current coatings. This means that there is already an existing market and infrastructure for greenhouse coating services. Furthermore, there are numerous knowledge institutions that focus on improving greenhouse cultivation methods, integrating and optimizing greenhouse technologies and systems. Kas2030, PRIVA, or Delphy are all organizations that provide support and expertise in greenhouse cultivation, which will help PAR+ provide their future customers with advice on how to alter the cultivation methods based on the implementation of the coating.
The only thing missing is that, there are currently no recycling companies. There are currently no rules against washing the coating into the sewage system. However, for the future, should there come more stringent regulations for waste disposal, new methods for waste disposal need to be considered.

In conclusion, there are no hindering factors for this building block, and there is no lack or need for complementary products and services currently. Therefore, this building block is compatible for large-scale diffusion of the PAR plus technology.

Network formation and coordination

The network formation and coordination are in good order according to FOTONIQ. The logistics for the distribution of the PAR+ coating are in place, and partners and

stakeholders are closely connected and helpful in the distribution process. This is a positive aspect for the large-scale distribution of the product, as it ensures a smooth and efficient distribution process. This is in part due to the availability of the Greenports in the Dhc. As previously stated, due to the Greenports growers, knowledge institutions, growers associations all have close personal ties. This enables new innovations which been acknowledged by growers due to their success in greenhouses, to quickly gain popularity. However, the down side of this is that technologies first need to be acknowledged but this will be discussed more for the Customer building block.
Overall, while the network formation and coordination for the PAR+ coating is ready for large-scale distribution of the product.

Customers

In the Dhc, it is crucial for the success of an innovation to have strong ties within the sector and with the growers. Unfortunately, PAR+ has encountered barriers as they struggle to establish themselves within the industry. PAR+ primarily targets growers who believe in the positive impact of diffuse light on plant production. Although research supports this claim, many growers are skeptical of research findings. Some growers do not believe that diffusing incoming sunrays has a positive effect on plant production.
Moreover, PAR+ is faced with a lack of trust from growers in their findings. While their measurements show that their coating does not decrease the amount of incoming solar light, and increases the amount of PAR light with an added diffuse effect, many growers are skeptical. The customers do not fully trust that the coating does not reduce incoming solar light especially over the promised 8 years of functionality. As such, many growers are reluctant to invest in the technology, considering it to be too risky at the current price point.
In conclusion, the Customer building block for PAR+ is not compatible for large scale diffusion. FOTONIQ needs to establish itself as a credible player in the Dhc building trust with growers in the industry.

Innovation-specific institutions

The final TIS building block is the innovation-specific institutions that could potentially impact its large-scale distribution. Firstly, there are no legislative barriers that may affect the need for recycling of the coatings. This means that the PAR+ coating can be treated in by existing waste water treatment plants from the sewage systems. Secondly, there is a lot of governmental support for sustainable development goals (SDG) tools in the Dhc, This support could help to promote the use of e PAR+ coating, and could also help with funding and other resources for the development and distribution of the product.
As such, the innovation-specific institutions are compatible for large-scale distribution of the coating.

Knowledge and awareness of technology

FOTONIQ has the knowledge and awareness of their products functions. They have ample scientifically tested data in regards to the coatings effect on diffusion and par density in different light intensities. According to the startup, their methods are used similarly by the WUR which speaks for their validity. However, the company lacks practical knowledge and data derived from functioning greenhouses. They are unable to advise potential customers on how to best integrate their product with existing cultivation strategies and greenhouse systems. Additionally, there is no evidence to support the claim that the coating will last for the promised 8 years or how it will perform over time.

The conclusion is that the knowledge and awareness of the technology is not enough to be compatible with large-scale production. This is largely concluded from the workshop with the startup based on the affects the missing knowledge has on the TIS building blocks, namely:

- Product performance and quality: The lack of knowledge regarding the effects the coating may have on the cultivation strategy affects the quality of the service FOTONIQ is able to provide for the growers.
- Product price: FOTONIQ is yet unaware if and how the taxation of the coating may be on growers, which effects the relative price of their coating compared to the once growers currently use.
- Customers: The lack of true scale results makes future customers hesitant to invest.

Knowledge and awareness of application and market

The startup is aware of how the specific coating can be applied and why it is beneficial to the Dhc market. The refraction of sunlight to increase PAR density is most useful for crop cultivation. Thew company has also knowledge in regards to what growers apply coatings in winter months, which are a prime target as initial customers.

In conclusion, the knowledge and awareness of the market is not limiting the startup ability to scale up the diffusion of their product.

Natural, human and financial resources

For this influencing factor, we will describe the status of each resource type. FOTONIQ is able to secure all the natural resources they need for their production, as their supply lines are in order. They also have multiple technicians working on both production and research and development, which have been essential for the production and testing of the coating. Their financial situation is also stable enough to support their current activities and staff.

However, one major limitation for FOTONIQ is their lack of sales, which means they do not have enough money to increase their production line. While this is not an issue currently, it may become a limitation when their product is diffused to the whole sector.

While FOTONIQ has the knowledge of what their production system should look like to scale up, they do not have the finances or sales to do so.

In conclusion, while this influencing factor is not a bottleneck for the startup in their current circumstances, the natural, human, and financial resources are not compatible with large-scale diffusion. This affects the following building blocks:

- Production system: There are not enough financial resources to fund a larger-scale production system.

Overall, while FOTONIQ does not need to address their resource limitations currently, they should be mindful of these limitations in order to scale up their production system for successful large-scale diffusion in the future.

Competition

There are two types of competitors for the PAR+ coating. These competitors compete with FOTONIQ on providing diffuse lighting solutions, not an increased PAR light density from natural light. The first are chalk or other types of temporary coating materials which are most often applied to the windows of the greenhouses for the winter months. The sector type of competitor is a more permanent diffuse options, be it diffuse glass or screens.
Compared to both these types of competitors, FOTONIQ is confident in the product-price benefit PAR+ has over these options. The temporary coatings might be cheaper for a single use, but the PAR+ coating is a cheaper option over the 8 year lifetime period of the product. This is excluding the positive effect the PAR light refraction has on the crop production of a greenhouse. The permanent options are much more expensive as compared to the PAR+ coating and need significant time investments on the grower's side.

The only negative side for FOTONIQ is that the current coating companies are much better known to the growers. The growers likely know these companies for a long time and the application methods, effects of coating are familiar. To break through to this, might be difficult for the startup as of yet, and take some time. However, this likely has more to do with the socio-cultural aspect then the competition per se.
In conclusion this influencing facto does not affect the TIS building blocks nor hamper the startup from large scale diffusion.

Macro-economic and strategic aspects

The macro-economic landscape of the Dutch horticulture sector appears to be very beneficial for startups formulating sustainable innovations. Growers are under economic pressure, forcing them to increase production value and reduce emissions. As such, the supply of PAR+ by FOTONIQ should motivate grower to adopting the coating. The only negative aspect is the current energy crisis. This has put certain growers in financial stress, lowering their willingness to invest in new and unproven technology. However, the

moment FOTONIQ prove the added the effect of their product to the growers, most growers will likely show great willingness to invest.

Overall, the macro-economic aspects are mostly compatible with large scale diffusion, but the success of adoption depends on how FOTONIQ can show the effect of the product over the promised product lifetime.

Socio-cultural aspects

In the previous chapters was described, how the socio-cultural dynamics of the growers and other stakeholders look like. Based on this understanding, the Dutch horticulture is a innovative sector which very close personal connections. As such, the socio-cultural aspects of the sector have both positive and negative effects on the product adoption of PAR+ in the industry.

Similarly to the case for Thermeleon, the strong sense of cohesion of the growers can have both a positive and negative side. On the positive side, many growers are open to innovate, especially regarding improvements to their crop quality or efficiency. In addition, once a grower is convinced of a products effects, others tend to agree as well. On the negative side however, startups who have not yet managed to gain a foothold into the sector will face reluctance from growers who are hesitant to change their traditional cultivation methods. Growers may be hesitant to adopt new non-field tested technologies. 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 the available results are not enough to convince growers of the positive effects of the coating on the plant and its 'shelf-life'. FOTONIQ needs to show how much the coating can improve the production and reduce operational cost by providing a coating for 8 years instead on one season.

In conclusion, the socio-cultural aspect of the Dutch horticulture sector present a challenge to the diffusion of the PAR+ coating.

Accidents and events

Similar to what was explained for the Thermeleon case, the most influential event now affecting the sector is the war in Ukraine. This tragic event has not only caused the energy and gas prices to increase significantly, but also reduced the food supply of Ukraine to the rest of Europe. As a result the need for more (energy) efficient food production has increased. This has made it almost necessary for growers to find ways to reduce energy costs and increase production efficiency, which is precisely what the PAR+ can provide for Dutch greenhouses. To conclude, this influencing factor has a positive effect on the diffusion possibility of the coating.