Implementing sustainable Internet of Things in horticulture

Graduation report - Dyantha Fisser

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Graduation report
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Acknowledgment

Dear reader,

In front of you is the final report of my graduation project of the Strategic Product Design master at the Delft University of Technology. Seven years ago, I started my journey at the Delft University of Technology. As a child I always wanted to be an architect. However, during my bachelor Architecture, I noticed that the world of architects isn't a world for me. Within my bachelor's degree, I missed the user interaction and the rationale of the design that I found in my masters at Industrial Design Engineering. I enjoyed my master's degree, and I'm proud to obtain my Master of Science in Strategic Product Design.

First of all, I want to thank KPN for providing me with this opportunity. I would like to thank Jeroen for giving me the opportunity and trust within my graduation project. I learned a lot from our weekly conversations and I enjoyed all chances you gave me to talk with anyone of KPN. Besides that, I also want to thank Jan Rijk for his hours of collaboration and knowledge exchange. I enjoyed meetings with you and I learned a lot from your experience. I also want to thank Ellen, Titia, Daan, Jacob, Niels, and all other colleagues who I talked to within KPN, for their critique opinion and enthusiastic reactions to my project.

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Besides that, I also want to thank all growers who were open to talking to me about their beautiful sector, their passion for their field of work, and the hard work that they deliver every day in their greenhouse. I would like to especially thank Pligt Professionals, who allowed me to take a look at his greenhouse and got even more insights into the horticultural sector.

Last but not least, I would like to thank all of my friends and family who made my graduation a little easier.
A special thank you to Ruben, for the mental support and hours of proofreading. Where I also would like to especially thank Simone and Tess, for the moments of tea and support when I needed it when we were at IDE.

Enjoy reading my thesis,

Dyantha Fisser

Executive summary

Dutch agriculture is a big sector for a small country like the Netherlands. After the USA, the Netherlands has the biggest export flow of agricultural products. The Dutch agricultural sector needed to increase its production over the years. Production increased as a result of new technologies, growing amounts of pesticides, and government policies that stimulate the increasing productivity of agriculture. Although these changes were fruitful, it is currently provoking environmental concerns. This is causing **pressure for growers to be more sustainable** in the last few years. Therefore, growers are embracing technology to produce more efficiently and sustainably.

To increase sustainability, growers need suppliers and other organizations who help them with achieving more sustainable production. Growers' need for technology is an **opportunity for KPN,** where KPN can provide ICT to unlock a better future for our planet and its people. There will not be a focus on all ICT solutions and the whole agricultural sector, but specifically on IoT solutions and the horticultural sector. Within this scope, the following challenge occurs:

"How to successfully launch sustainable IoT solutions in the horticultural sector?"

To make the biggest sustainable impact, **all stakeholders of the supply chain need to collaborate** to make the sector more sustainable. Therefore, it's needed to create an ecosystem for continual innovation, to eventually be a more sustainable sector.

Interviews with different growers lead to the following knowledge: **growers want to adopt sustainable IoT solutions if it's an improvement, when it's affordable, trustworthy, and long lasting.** To achieve these four requirements it's important to understand their need. Currently, their current technology suppliers are most trustful and have the biggest chance of launching a sustainable IoT solution. While their biggest current need is to get real-time feedback, to improve their crops' growing process.

IoT can be applied to automate the horticultural processes, which leads to **reduced usage of resources**, such as water, electricity, and pesticides, to increase the sustainability potential. However, this needs to be done in a way that also decreases the pressure of innovation and improvement without an end goal. Therefore the following design challenge occurs:

Design a strategy to innovate the horticultural sector durably.

By means of a creative session, three concepts are developed to innovate the horticultural sector durably. Where one concept is chosen to have the most potential: **The Monitoring Service**. Monitoring Service is a service which automatically fulfills the need of the crops. Data is gathered by sensors. This data is in the beginning only used to train the algorithm to know the optimal growing process of the crops. When this algorithm is trained a digital twin can be made which is a digital copy of the greenhouse. Digital twin is constantly updated by real-time data from the sensors. The digital twin can be compared with the optimal growing process of the AI algorithm, to know what every plant needs to optimally grow, while only using the needed resources. This Monitoring Service can be developed by three steps: Become a smart grower, Become a remote grower and Become an autonomous grower.

The major requirement to realize and succeed the Monitoring Service, **financial barriers need to be decreased** to minimize the costs for the grower. Therefore it's important to collaborate with investors. Another possibility to decrease the costs for the grower is to fund the proof of concept by KPN. This will decrease growers' costs, which is a benefit for the first grower who participates in the first version of the Monitoring Service. KPN can finance the implementation of the Monitoring Service, while the grower only needs to pay for the service when it's working optimally.

To be able to develop this solution, an ecosystem is needed to realize the Monitoring Service. The most important partner is a current **horticultural technology supplier**. This partnership has the benefits to easily enter the horticultural market, create more market knowledge, and makes it easy to contact the first prospects.

Within the ecosystem, **KPN provides the connectivity** to connect all technologies with the platform. Besides the connectivity, KPN also sells its service as data safe. This data safe is a service that guaranteed the safety of the data, which keeps collected within the ecosystem. This gives growers the ownership of their data, where it's also visible for other stakeholders in the ecosystem for further development of the solution. For KPN this service is also known as **Data Services Hub**, which is sold as a platform-as-a-service that translates data into information and shares data with the approved stakeholders.

To conclude, IoT can be applied to increase the sustainable potential of the horticultural sector. IoT is mostly used to automate and increase the effectiveness of processes, where IoT can help the horticultural sector to decrease the number of needed resources and increase their productivity. Therefore it's key to know the **optimal growing process of the crops**, which is learned by complex AI algorithms.

To develop the Monitoring Service it's key to **collaborate with multiple stakeholders** within an ecosystem to make the horticultural sector more sustainable. The potential for KPN to be part of an ecosystem in the horticultural sector is available. However, to enter the market, KPN should create a better understanding of the market, the growers' problem, and the current stakeholders. Therefore it's key to start talking with current technology suppliers of the horticulture to get more in-depth knowledge of which technologies are needed to help growers.

Based on the research, there is a big chance for KPN to sell the Data Services Hub, the data safe as a service. This could be the starting point of trustful and safe collaboration between growers. This is needed to **let growers collaborate in a trustful and secure way**, which could make a change for innovations in the horticultural sector.

Content

01 Introduction

The first chapter gives an introduction to the research for this graduation project. The introduction is divided into three parts. The first part gives a brief introduction to KPN; the client for this project. The second part will dive into agriculture; the context for this project. The last part of this chapter provides the problem definition; identifying the goal of the project.

Content

1.1 A company introduction of KPN

Koninklijke PTT Nederland NV (KPN) is a Dutch telecommunication company, one of the frontrunners in digitalization (KPN, 2020). KPN started as an initiative of the Dutch government for the post, telegraphic, and telephony, however, in 1989 KPN became a private firm (KPN, n.d.-e). The main business of KPN is focused on mobile telephony and the internet. KPN reaches both business-to-consumer (B2C) and business-to-business (B2B) markets. For its B2C customers, KPN provides telephony, internet, and T.V, while for B2B customers KPN provides telephony, internet, and also diverse end-to-end solutions. Within this graduation project, KPN is the client and the focus is on its B2B market.

1.1.1 KPN's B2B market

At the B2B market, KPN offers different products as mobile connections, internet, telephone connections, television subscriptions and ICT (information and communication technology) solutions such as the Internet of Things (IoT), security, cloud and workspace, connectivity and smart combinations. Within this graduation project, there will only be a focus on IoT in the Netherlands.

KPN mainly focuses on three sectors: public, manufacturing, and healthcare. The main sectors are chosen because of the high potential of profit. Next to this, KPN is also focusing on other sectors which are explored by its Fieldlabs. KPN has five different Fieldlabs: rural, industry, mobility, urban area, and care (KPN, n.d.-c). Within these Fieldlabs, KPN works together with technology partners, customers, and suppliers to optimize its technology. Within these Fieldlabs KPN develops new products and services based on its principle "business first, technology second" (KPN, n.d.-c).

Within the B2B market KPN starts to switch to a business model where KPN not only sells technology, but works together in an ecosystem with other stakeholders, such as technology partners, customers, and suppliers to strive together for new business potentials. This new approach is an element of its strategy 'accelerate to grow', where KPN wants to be connected with its customers. KPN approaches its B2B market as a B2B2X. KPN sells its services to a business customer, who is an expert of the sector they are operating in (KPN, internal analysis). The 'X' in B2B2X, which is visualized in figure 1, represents multiple possibilities: the end user and consumer or the secondary stakeholders which are other business customers.

Figure 1: B2B2X approach (own ill.).

An example of B2B2C is the connectivity for Tesla, where KPN sells its connectivity to Tesla and Tesla integrate this in its cars and sells connected cars to its consumer (van der Beek, 2014). An example of B2B2B is the connectivity of smart waste bins, where KPN sells its connectivity to a company that produces trash bins, which sells its connected trash bins to organizations such as municipalities, NS, and Schiphol. In this way, these organizations could use these connected trash bins to see which one are filled and need to be cleaned, instead of inspecting all trash bins manually.

1.1.2 Sustainability

Sustainability is one of the five themes of KPN. According to the Dow Jones Sustainability Index, KPN belongs to one of the most sustainable telecommunication companies in the world (Emerce, 2020). KPN uses only 100% green electricity since 2011 and became fully climate neutral in 2015 (KPN, n.d.-a). To preserve its position as the most sustainable telecommunication company in the world, KPN strives to be 100% circular by 2025 (KPN, 2020). To be 100% circular, all of its product components and used raw materials should be reusable or recyclable. KPN had this goal set to contribute to the national Dutch goal: to be 100% circular in 2050 as a country. To get to this goal, KPN (n.d.-b) states:

"We believe ICT is the key to unlocking a better future for our planet and its people".

To not only be 100% circular as a company but also help other companies to be 100% circular, KPN provides ICT to its customers to help them become 100% circular. While helping its customers be circular, there also needs to be a benefit for KPN. Therefore, to identify where KPN has the biggest revenue potential, Accenture Strategy (2016) analyzed different Dutch sectors. Figure 2 describes which Dutch sectors could benefit from ICT solutions with sustainable benefits sorted by revenue potential.

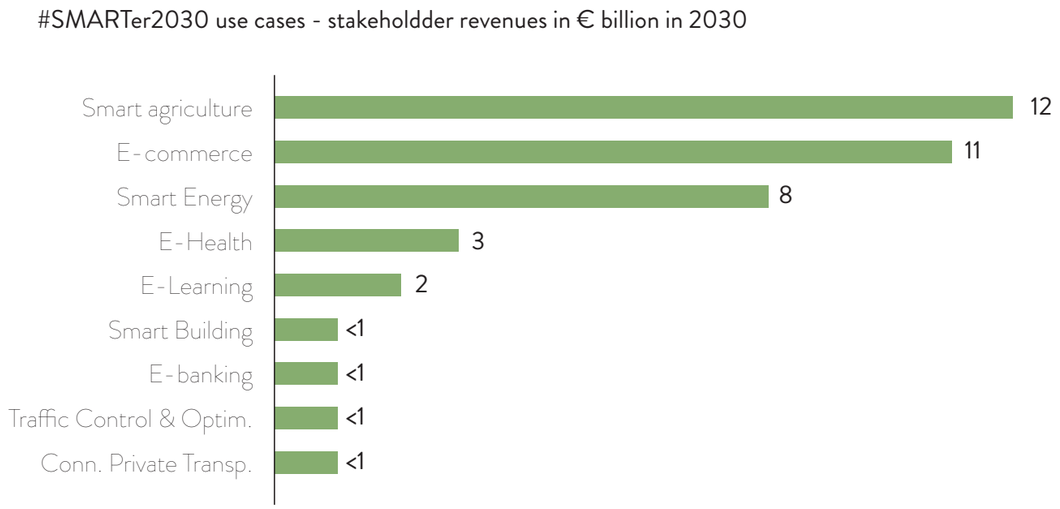


Figure 2: Revenue potential of ICT solutions with sustainable benefits (Adapted from Accenture Strategy, 2016).

The revenue potential of Dutch smart agriculture is the highest, 12 billion in 2030. There is a big opportunity for KPN to increase its potential revenue by helping agriculture be more sustainable with ICT. However, KPN is not a big market player in the agricultural sector yet. To get a better idea about the sector, paragraph 1.2 shortly explains the need for sustainability and ICT in the agricultural sector.

1.2 The context: Agriculture

Dutch agriculture is a big sector for a small country like the Netherlands. After the USA, the Netherlands has the biggest export flow of agricultural products (Ministerie van Economische Zaken, Landbouw en Innovatie, 2017). Because of still increasing export, the Dutch agricultural sector needed to increase its production over the years. Production increased as a result of new technologies, growing amounts of pesticides, and government policies that stimulate the increasing productivity of agriculture (Veldkamp et al., 2009). Although these changes were fruitful, it is currently provoking environmental concerns (Veldkamp et al., 2009). This is causing pressure for farmers to be more sustainable in the last few years. Therefore, farmers are embracing technology to produce more efficiently and sustainably (King, 2017).

While Dutch farmers are striving for more efficient and sustainable farms, there is still a lot of critique to be even more sustainable (Wageningen University & Research, 2017). To increase sustainability, farmers need suppliers and other organizations who help them with achieving more sustainable production. Farmers' need for technology is an opportunity for KPN, where KPN can provide ICT to unlock a better future for our planet and its people. However, KPN does not has much expertise in the field of agriculture yet, therefore a problem occurs when KPN wants to enter the market.

1.3 Problem statement

To be able to enter the market, KPN needs to understand the agricultural market. Therefore KPN should learn from farmers and other stakeholders how to be could be beneficial for agriculture. This collaboration ensures multiple stakeholders working together in an ecosystem, which all contribute to a successful outcome. The problem of different stakeholders within an ecosystem is that different stakeholders mostly represent their own interests. This could lead to oversee the interest of the ecosystem as a whole, which will decrease the potential of the outcome of the solution. As said above, there will not be a focus on all ICT solutions and the whole agricultural sector, but specifically on IoT solutions and the horticultural sector. Within this scope, the following challenge occurs:

How to successfully launch sustainable IoT solutions in the horticultural sector?

The goal of the project is to investigate how an ecosystem could be created, which provides technological solutions to improve sustainability in agriculture. Within this goal, the role of KPN must be clarified, because this is the client of the project. By defining the role of KPN the subgoal is to define the strategic approach of KPN towards creating an ecosystem, its added value to the ecosystem, and its launching strategy for the agricultural market.

1.4 Main take-aways

Project client KPN - Dutch telecommunication company
Problem How to successfully launch sustainable IoT solutions in the horticultural sector?
Challenge How an ecosystem could be created, which provides technological solutions to improve sustainability in agriculture? And which role KPN should take within this ecosystem?
To be determined next To know how sustainable IoT solutions need to be launched in the market, it first needs to be determined how sustainability can be improved by using technology. This is further elaborated in chapter 2; sustainable change.

02 Sustainable change

This chapter is based on literature describing how sustainability can be improved by using technology and how companies can innovate to create more added value to a sustainable society. The chapter is divided into five paragraphs. The first paragraph addresses the importance of sustainability and how companies should focus on sustainability. The second paragraph explains the Internet of Things (IoT), and how IoT can increase sustainable performance. The third paragraph elaborates on sustainable business models and how companies need to change to be more sustainable. The fourth paragraph investigates ecosystems, and how important ecosystems are to improve the sustainable performance of a sector. All these paragraphs are summarized in the fifth paragraph, which results in the research question of this project, to indicate the importance of this project.

Content

2.1 Sustainable importance

In the past quarter-century, there is more awareness of the need for sustainability. Evidence shared on social media, where climate change causes real problems, such as heavy weather and an increasing earth temperature, what is seen by consumers, government organizations, and companies in all different sectors (Kassel, Rimanoczy & Mitchell, 2016). Documentaries such as 'A life on our Planet' by David Attenborough and 'An Inconvenient Truth' of Al Gore, show consumers and employees of companies and organizations the importance of sustainability. If humans don't change the way they live, the earth's temperature keeps increasing, nature fades away, and more resources come to an end (Gore & West, 2015).

To identify what sustainability is, the definition of the World Commission on Environment and Development is used, which is stated by Dao, Langella & Carbo (2011): "...development that meets the needs of the present without compromising the ability of future generations to meet their needs.". To make this definition less theoretical, and more approachable within a business context as to where KPN is in, it's easier to look at sustainability with the triple bottom line perspective. The triple bottom line perspective of sustainability is visualized in figure 3.

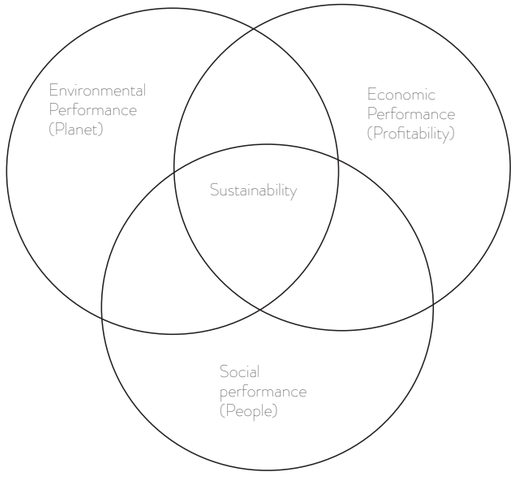


Figure 3: Triple bottom line perspective of sustainability (Dao, Langella & Carbo, 2011)

Figure 3 visualizes that sustainability is finding the balance between environmental performance, economic performance, and social performance. The economic performance of a company is included because long-term economic benefits are secured while the company also balances the environmental and social performance (Aguilera, 2007). Therefore, companies need to focus on sustainability to get a long-term profitable perspective and existence rights in the current society.

The research question of this project isn't only focusing on sustainability, but also the impact about IoT on sustainability. Therefore, the relationship between sustainability and IoT is analyzed in the next paragraph.

2.2 Influence of IoT on sustainability

To analyze the influence of IoT (Internet of Things) on sustainability, IoT needs to be defined first. IoT ensures physical objects, which are equipped with sensing, actuating, and computing power, to perform their task while being connected to the internet (Lakhwani et al., 2019). The ultimate goal of IoT is, due to IoT, everything is connected all the time, everywhere, for everyone (International Telecommunication Union, 2005), see figure 4 for the visualization of this goal. IoT exists of 4 main components: 'network', 'hardware', 'software and algorithms', and 'data processing' (Lee & Lee, 2015). Hardware as a component is referring to the "Thing" in the Internet of Things. For the word "Thing", Minerva, Biru, and Rotondi (2015) refers to: "any physical object that is relevant from a user or application perspective". The definition of IoT derived from the work of Minerva, Biru, and Rotondi (2015) is:

"An IoT is a network that connects uniquely identifiable "Things" to the internet. The "Things" have sensing/ actuation and potential programmability capabilities. Through the exploitation of unique identification and sensing, information about the "Thing" can be collected and the state of the "Thing" can be changed from anywhere, anytime, by anything."

IoT has the potential to have a big impact on the environmental performance of companies (Nasiri, Tura & Ojanen, 2017). Example benefits of IoT are economical savings, a decrease in energy and water consumption, waste reduction, and reduced fuel consumption. To make a positive sustainable impact with IoT all three performances of the triple bottom line need to be improved by companies. The social performances of a company can be improved by the standards of life, for example, the working conditions of employees (Nasiri, Tura & Ojanen, 2017). Economic performance can be improved by IoT

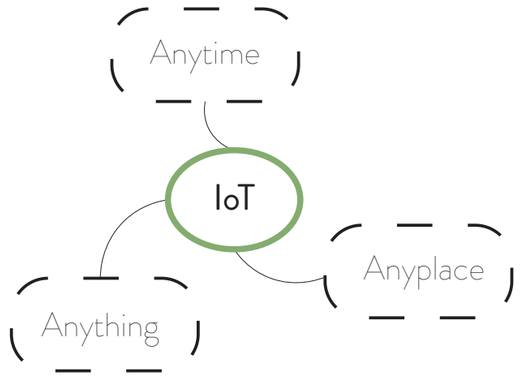


Figure 4: Visualization of IoT definition (own illustration)

through improving productivity, increasing economic growth, and competitive advantages for companies (Nasiri, Tura & Ojanen, 2017). On the environmental performance, it is required to reduce the usage of natural resources and the energy consumption by IoT to increase its sustainability impact on companies (Nasiri, Tura & Ojanen, 2017).

To eventually make the biggest sustainable impact, it's not only required for the company, but for the whole supply chain to be more sustainable (Dao, Langella & Carbo, 2011). When one company becomes more sustainable by using IoT, but therefore another supplier in the supply chain needs to use more fuel to provide for IoT it's still not sustainable beneficial. Therefore it's even more beneficial if all individual stakeholders of the supply chain work together as if they are one ecosystem (Dao, Langella & Carbo, 2011). These collaborative ecosystems are becoming more popular in the past few years (Tsujimoto, Kajikawa, Tomita & Matsumoto, 2018). Nevertheless, to understand why these collaborative ecosystems are becoming more popular, first it needs to be elaborated on how sustainable business models have applied to increases the sustainable performance of a company.

2.3 Sustainable business model innovation

Contributing to a sustainable future requires changes in all industries, and requires organizations to change to sustainable business models. A sustainable business model is defined by Lüdeke-Freund (2010) as "a business model that creates competitive advantage through superior customer value and contributes to the sustainable development of the company and society".

To successfully apply a sustainable business model to integrate sustainability at the organizational level, Geissdoerfer et al. (2018) state that three big elements need to be taken into account: "sustainable value creation, more pro-active management of a more comprehensive set of stakeholders, and a long-term perspective". These three big elements agree with the triple bottom line perspective which is mentioned in paragraph 2.1, however, the added value is to also include the interests of a broader set of stakeholders than only the company. According to Geissdoerfer, Bocken & Hultink (2016), a sustainable business model is accomplished by: "enhancing operational efficiency on a technological, by stepping up value generation capabilities on a factory planning, and by performing effective stakeholder management on a corporate strategy level".

To create a sustainable business model, companies need sustainable business model innovation (Yang, Evans, Vladimirova & Rana, 2017). Björkdahl and Holmén (2013) define the term business model innovation as followed: "A new integrated logic of how the firm creates value for its customers or users and how it captures value and is the implementation of a business model that is new to the firm". To also contribute to a sustainable future, the sustainable business model innovation process can help organizations to include sustainable value and manage all stakeholders which are needed to make the business model a success (Geissdoerfer, Bocken & Hultink, 2016). How all stakeholders are managed within a sustainable business model is visualized in figure 5.

Figure 5: The sustainable business model concept (Adapted from Geissdoerfer, Bocken & Hultink, 2016).

Figure 5 shows the importance of collaborations of all stakeholders, to make the sustainable business model work. The organization secures economic, social, and environmental value, where all other stakeholders collaborate and deliver and exchange value towards each other. This collaboration is beneficial for each stakeholder, where they all transfer or deliver value and work together in a properly working ecosystem. The next paragraph 2.4 explains how ecosystems work to be successful.

2.4 Successful ecosystem design

A simplified example of a traditional linear development is visualized in figure 6. Within this traditional linear development value delivery and exchange is transferring linear from one to another stakeholder.

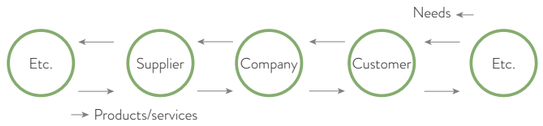


Figure 6: Simplified traditional linear supply chain (own illustration).

However, over the last years this nonlinear development, like ecosystems, became increasingly more popular to innovate (Tsujimoto, Kajikawa, Tomita & Matsumoto, 2018). The ultimate goal of an ecosystem is to work together with all stakeholders to transfer knowledge and technologies to come up with new solutions (Russell & Smorodinskaya, 2018).

There are different definitions for an ecosystem, nevertheless, for this project, the definition of Granstrand & Holgersson (2020) is used: "the collaborative arrangements through which firms combine their offerings into a coherent, customer-facing solution". The aim of co-creating within an ecosystem is to work in collaboration towards new products and innovations to fulfill the customer needs and work together towards innovations (Granstrand & Holgersson, 2020). This obligates companies to switch from competition to collaboration. Collaborations start with business networks, which idealistically lead to ecosystems for continual innovation. This is shown in figure 7 (Russell & Smorodinskaya, 2018).

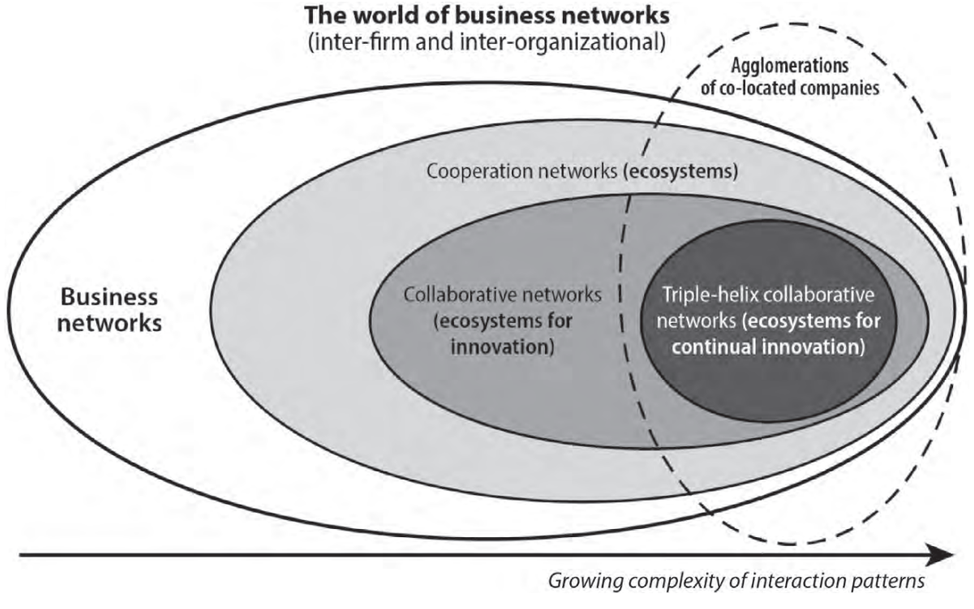


Figure 7: The process from networking to ecosystems (Russell & Smorodinskaya, 2018).

To establish an ecosystem for continual innovations, the first step is to network. When this network leads to the next phase of cooperation networks, where different organizations work together towards one certain solution or activity. For this solution, organizations work together, but this does not include that they have shared responsibilities.

The next phase, collaborative networks, which are ecosystems for innovations are ecosystems of a higher level. These ecosystems are created when all stakeholders of the ecosystem have the same strategy or same goal that they want to achieve with this ecosystem.

The highest level of an ecosystem is the ecosystem for continual innovation. An ecosystem for continual innovation exists of stakeholders from at least three different sectors. This could, for example, be an ecosystem that exists out of the business sector, knowledge institutions, and public organizations. Within this ecosystem, there is a maximum exchange of knowledge and collaboration, while these are the most complex ecosystems because of the many different stakeholders (Russell & Smorodinskaya, 2018). The outcome of this ecosystem for continual innovation is to increases productivity by collaborating, because every stakeholder in the ecosystem has another complementary skill, which all work together towards one shared action or goal (Porter & Ketels, 2009).

To make an ecosystem for continual innovation work, there needs to be a reduced amount of uncertainties in the process of innovation (Iansiti & Levien, 2004). Uncertainty is created if a lot of changes occur in the context, for example by innovations of the ecosystem. To keep the uncertainty as little as possible, the probability of mistakes of technological performance need to be as low as possible, there also needs to be a positive market response towards the innovation and there needs to be an acceptance of all stakeholders to the changes (Fukuda & Watanabe, 2012). Balancing the uncertainty and change of innovation gives the possibility to achieve sustainable development with an ecosystem for continual innovation.

2.5 Research question

To sum up the context provided by the last paragraphs, sustainability is explained by the triple bottom line perspective, where the economic, social, and environmental performance of a company is important to create more sustainable performance. Besides that, the term IoT is explained, and it has been emphasized that IoT can contribute to sustainability. To be sustainable as a company, companies need to switch to a sustainable business model and need to undergo sustainable business model innovations. To make the biggest sustainable impact, all stakeholders of the supply chain need to collaborate to make the sector more sustainable. Therefore, it's needed to create an ecosystem for continual innovation, to eventually be a more sustainable sector. To create this ecosystem successfully it's needed to keep the uncertainty in the process of innovation as little as possible, to create market acceptation and make sure innovations are accepted and used in the sector.

However, in the literature, it isn't stated how to set up an ecosystem for continual innovations to increase the sustainability potentials of the sector. This is determined as a research gap of the literature, where this research investigates the following research question:

How to set up an ecosystem for continual innovations to increase the sustainability potentials of a sector?

To answer this research question, this project will delve into the Dutch agricultural sector. The Dutch agricultural sector is used as an example of how to set up an ecosystem for continual innovations which increases sustainability. Within this ecosystem, there is mostly looked at how IoT can increase sustainability. To keep the uncertainty as little as possible, it is needed to dive into the Dutch agricultural sector to understand the market and all stakeholders.

2.6 Main take-aways

Sustainability importance To increase sustainable importance in a company, the company needs to increase its economic, environmental, and social performance.
Influence of IoT on sustainability IoT can help as an innovation to increase the sustainable performance of a sector.
Sustainable business model innovation To become a sustainable organization, organizations need to use sustainable business model innovation to switch to a sustainable business model. To secure sustainable improvement the organization needs to secure economic, social, and environmental value, where all other stakeholders of the supply chain collaborate and deliver and exchange value towards each other.
Successful ecosystem design A successful ecosystem for continual innovation increases productivity by collaborating because every stakeholder in the cluster has another complementary skill, which all work together towards one shared action or goal.
Research question How to set up an ecosystem for continual innovations to increase the sustainability potentials of a sector?
To be determined next Literature shows that to create an ecosystem for continual innovation it's needed to let the uncertainty be as little as possible. Therefore, technology risk needs to be as low as possible, and there must be a positive market response. To investigate how to create this positive market response to innovations of this ecosystem, it is needed to dive into the Dutch agricultural sector to understand the market and the innovations which are currently developed within this sector.

03 Sustainable agriculture

In this chapter, the Dutch agricultural sector is investigated. The goal of this chapter is to get an idea about the sector and its current technologies which help the sector become more sustainable. The chapter is divided into three parts. The first paragraph investigates the current technology use of agriculture. The second part dives into the different sub-sectors. And the last part will elaborate further on one of the sub-sectors and their views towards sustainability.

Content

3.1 Smart farming

Currently, agriculture is going through the fourth revolution of increasing technologies in agriculture (Walter, Finger, Huber & Buchmann, 2017). This fourth revolution is caused by the increased pressure of a growing population on the one hand, and a decrease of agricultural lands because of the increasing industrialization and residential buildings on the other hand (Dagar, Som & Khatri, 2018). Implementing IoT in farming increases the productivity of the sector, this is also called smart farming or precision farming (Dagar, Som & Khatri, 2018). With smart farming, farmers can automate their processes and integrate their knowledge with products to improve the productivity of their processes and also increase their crop quality (Elijah, et al. 2018).

Before smart farming helped the farmers, farmers needed to use older devices for their work. In this situation, farmers made decisions by farming their crop based on their knowledge which isn't including data from past years' weather reports or market demands (Dagar, Som & Khatri, 2018). While smart farming uses connected devices of IoT to guarantee the best conditions for their crops to grow (Dagar, Som & Khatri, 2018). These technologies don't only improve the productivity of their process, but also help farmers to decrease resources, which leads to a decrease of ecological footprint, to be more sustainable (Walter, Finger, Huber & Buchmann, 2017).

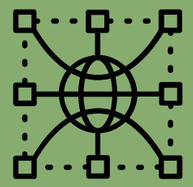
In paragraph 2.2 the sustainable benefit of IoT is explained. IoT can be categorized into three different categories: 'monitoring and control', 'big data and business analytics and 'information sharing and collaboration' (Lee & Lee, 2015).

Monitoring and control

The first category, monitoring and control, gives users the convenience to constantly get insights into their data and the convenience to change the input to get other output (Lee & Lee, 2015). An example of this category in agriculture is climate control within a greenhouse. Climate control involves sensors that measure humidity and temperature, which are sent via a network to an application that shows the farmer the humidity and temperature. With this application, the farmers can control the humidity and temperature and have the benefit of always controlling the climate within a greenhouse.

Big data and business analytics

The second category, big data and business analytics, gives businesses the convenience to get data about their business created by sensors and actuators. These data could be used to analyze the consumer behavior of their users, and use this data to increase consumer satisfaction (Lee & Lee, 2015). An example of this category is used within arable farming with soil sensors. Soil sensors within the soil of arable measure the status of the soil. Which is send back to farmers, so they know for example if their soil needs to be watered. The data of the sensors is also shared with the supplier of the sensors, which could use this to improve other techniques or see problems farmers are facing. These problems are business opportunities for suppliers to make even more IoT solutions to help farmers with their problems.



Information sharing and collaboration

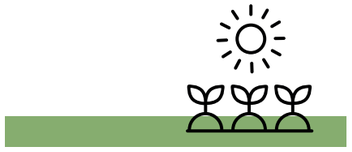
The third category, information sharing and collaboration, stimulates information sharing and collaboration, where IoT provides the option of communication between people, between things, and also between things and people (Lee & Lee, 2015). An example of this category of agriculture is an IoT tag that measures the health of cows every hour of the day. This tag hangs around the neck of a cow, which continuously measures the health of the cow; recognizing the chewing, walking, or rumination behavior. These behaviors give the farmer insights into how healthy the cow is or when the cow is draughty, so the farmer can step in at the right time or call the veterinarian to prevent the cow from falling ill.

While there already are smart farming technologies used by farmers, there are still barriers to overcome. The biggest barrier for farmers who resist them to invest in technology is the economic barrier (Caffaro & Cavallo, 2019). Another barrier is the ownership of the data, which is now mostly owned by the owner of the technology. When other authorities such as the government also get the right to use certain outputs, new business models are created for the data owners (Walter, Finger, Huber & Buchmann, 2017). In this case, the technology supplier doesn't only make a profit by selling technologies, but by selling data. Another challenge of smart farming is the responsibility and liability of technologies (Walter, Finger, Huber & Buchmann, 2017). What happens when technology has an error, and can't deliver the operation it needs to do, who will pay for this error? Paragraph 4.3 investigates more of farmers' needs and investigates their view on sustainability and technology.

Smart farming is tailor-made for a specific needs of the farmer. In the Netherlands, there are different subsectors of agriculture, where the needs of the farmer are different for all sectors. Therefore the next paragraph elaborates on the different sub-sectors of agriculture.

3.2 Sectors of Dutch agriculture

The agriculture sector can be divided into different main sub-sectors; arable farming, horticulture, and livestock sector (CBS, 2021).



Arable farming

Arable farmers are mainly producing potatoes, grains, sugar beets, and onions. Besides that, arable farmers are also cultivating vegetables such as peas, spinach, carrots, and various types of cabbage (Nederlandse Akkerbouw Vakbond, 2017). Arable farmers are currently trying to become more sustainable, where their main focus is on crop protection, soil management, new breeding techniques, and precision agriculture (Nederlandse Akkerbouw Vakbond, 2017).

Livestock

The sub-sector livestock is keeping livestock to produce dairy, eggs, and meat. The livestock sector is focusing on reducing waste, reducing greenhouse gases, increasing the welfare of their animals, and reduce the spread of animal diseases (Ministerie van Economische Zaken, Landbouw en Innovatie, 2020).

Horticulture

Dutch horticulture growers are producing vegetables, flowers, and plants. Currently, horticulture is mainly concerned with energy sustainability and CO2 reduction (Glastuinbouw Nederland, 2021). Some greenhouses started to use geothermal energy instead of natural gas to produce heat, light, and electricity. They also try to minimize CO2 emissions and recycle as many resources as possible.

To get more in-depth results for this project, the scope of this project is horticulture. As said in paragraph 2.4 an investigation is needed on how to set up an ecosystem for continual innovations to raise the sustainability potential, focusing on horticulture. Therefore, first, it's needed to investigate what sustainability potentials the horticultural sector envisions to connect this project to their future vision.

3.3 Future vision of the horticultural sector

The horticultural sector strives to be climate-neutral in 2040 (Glastuinbouw Nederland, 2019). To be climate neutral, the whole sector cannot emit any CO2. To reach this goal, there are different energy sources in which the sector invests. The energy within greenhouses is used to control the temperature, to keep the lights on, and control all technology. To only use energy that doesn't emit any CO2, all greenhouses need to switch to geothermal energy, sustainable energy, such as wind and solar energy, heat from biomass, or residual heat from factories.

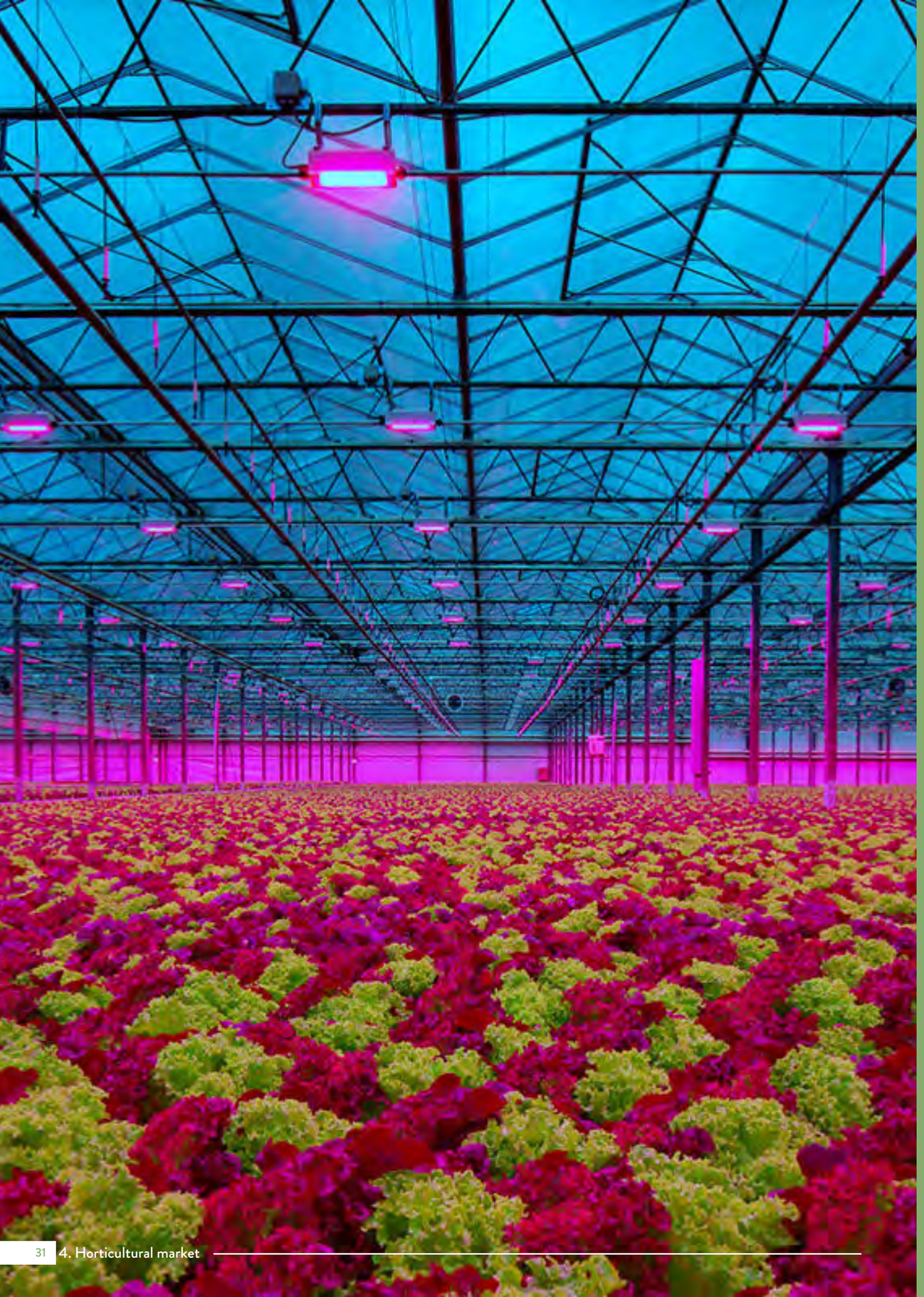
There are already some greenhouse growers which are already climate neutral. One of the climate-neutral growers states: *"Thanks to geothermal energy, we can grow CO2 neutral. Whenever all other conditions, such as price and quality are equal, buyers prefer to choose a sustainably producing company. We assure ourselves a future; sustainable production will become a standard condition."* (Glastuinbouw Nederland, 2019).

However, this is not economically achievable for all growers. Therefore Glastuinbouw Nederland is in consultation with the government to get subsidies for sustainable energy and wants to invest themselves in sustainable energy (Rijksdienst voor Ondernemend Nederland, n.d.). A consequence of only using sustainable energy is that the use of LED lighting needs to increase (Glastuinbouw Nederland, 2021). This is sustainable beneficial, and also beneficial for plant growth. With LED lighting it's possible to optimize the growing process by different colors and intensity of the lighting (Glastuinbouw Nederland, 2021).

Another aspect in which Dutch horticulture is striving to have water-efficient emission-free greenhouses in 2027 (Stichting Kennis in je Kas, 2019). This means to decrease the pesticides, fertilizers, and light from greenhouses into the environment to zero. What will lead to emission and residue-free cultivation in 2040 (Stichting Kennis in je Kas, 2019). To reach this goal the use of alternative crop control need to increase, which can be done by technological or biological innovations (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2019).

3.4 Main take-aways

Smart farming Smart farming is the implementation of IoT in farming to increase the productivity of the sector and has the benefit of also help increase sustainable potentials.
Sectors of Dutch agriculture There are three different sectors: arable farming, horticulture, and livestock sector. This project will focus on horticulture where vegetables, fruit, plants, and flowers are produced within greenhouses
Future vision of horticultural sector The horticultural sector strives to be climate-neutral in 2040. This needs to be accomplished by only using sustainable energy, using sustainable lightings such as LED, and decreasing pesticide usage.
To be determined next This chapter gave an overview of the agricultural sector and some examples of its current sustainable technologies. There is also elaborated on the chosen focus sector: The horticultural sector, and its future vision on sustainability. However, the client of this project is KPN which is currently not described in this context. Therefore the next chapter analyses the current situation of KPN in horticulture and analyses its market opportunities.



04 Horticultural market

To identify the market opportunities for KPN in the smart horticultural market, a 4C analysis is done. The goal of this 4C analysis is to gain more insights into the strategic position of KPN within the market. To discover its strengths and weaknesses to identify its opportunities and threats by entering the smart horticultural market. The 4C analysis exists out of the four key C's: Context, Company, Customers, and Competitors. The first paragraph investigates the supply chain and trends of the context. The second paragraph elaborates on KPN's current position within the smart horticultural market. The third paragraph analyses the growers' view of smart horticultural innovations as the end-consumer. And the last paragraph investigates the competitor market while using Porter's five forces model.

Content

4.1 Context of horticulture

Dutch horticulture is one of the sub-sectors of agriculture, within horticulture, crops such as fruits, vegetables, and ornamental plants are growing inside greenhouses. The horticulture sector is the largest sub-sector in Dutch agriculture measured by economic size (CBS, 2021). To understand the context of the horticultural sector, the supply chain is analyzed, and a DESTEP analysis is done to get a better understanding of the future trends of the sector and the market opportunities for KPN.

4.1.1 Supply chain

Before products can be bought by consumers, there is a whole supply chain that is needed to produce these products. The supply chain is shown in figure 8.

The growers are placed in the center of this supply chain, because they produce the products, such as tomatoes, peppers, flowers, and plants. To produce these products they need to have resources. These resources differ from resources such as seeds, fertilizers, and crop protection to technological supplies such as crop optimization technology and climate control. Besides that, the government is also included in this supply chain. The government needs to meet the requirements of the climate agreement, where the government strives to have less CO_2 emissions (Nederlandse Emissieautoriteit, 2017). Therefore, the government is in consultation with lobbyist organizations of the horticultural sector, such as Glastuinbouw Nederland and LTO Nederland. The goal is to work together on a realistic approach towards a sustainable sector. The horticultural sector is the only sector that is consulting with the government in this way, and therefore gets financial help from the government to achieve more sustainable greenhouses (Glastuinbouw Nederland, internal analysis).

The need for a more sustainable earth is not recognized only by politics with the climate agreement, but also by individual consumers. They are at the end of the supply chain. In the past few years, consumers want to buy more sustainable products, which results in the fact that consumers are willing to pay more money for sustainable products (Yang, 2017). Therefore wholesales are adjusting their product requirements, to only sell sustainable products, while their purchase price isn't increasing (van Bekkem & de Vries, 2020). These sustainability requirements result to be the problem of the growers (van Bekkem & de Vries, 2020).

Some of the product suppliers take responsibility and pay more for sustainable products, however, these are still very rare to find. The government, LTO Nederland, and Glastuinbouw Nederland try to help growers to be more sustainable by giving a subsidy (Rijksdienst voor Ondernemend Nederland, n.d.). However, still, with these subsidies it's hard to meet the requirements of wholesales, keeping innovative, and be profitable (Bekkem & de Vries, 2020). This allows technology suppliers to add value to the growers. In the current supply chain, KPN is placed

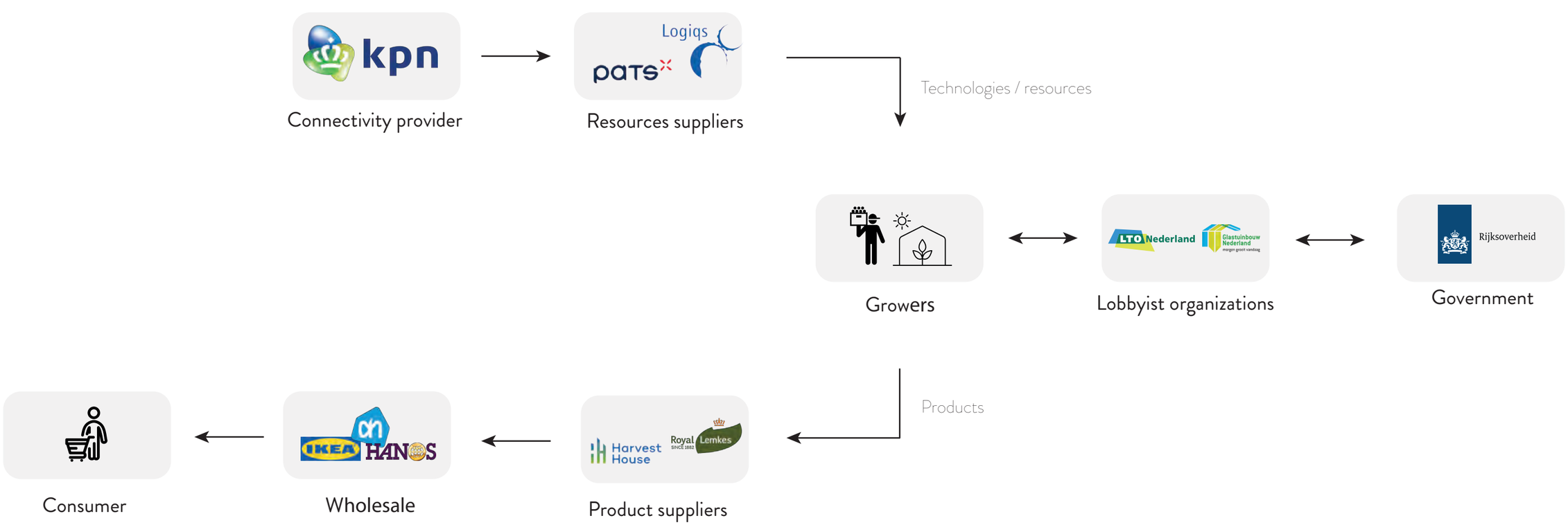


Figure 8: Supply chain of horticulture (own illustration)

before the technology suppliers. Technology suppliers are seen as customers of KPN. In this collaboration, KPN trusts the sector-specific knowledge of their customer, and mostly sells their connectivity, while at the same time advice about the development of the technology supplier based on their connectivity knowledge. KPN is a connectivity expert and sells its connectivity in many sectors. This broad approach results in a less scoped approach, which leads to less expertise in specific sectors. This could be seen as a bubble which KPN creates by only approaching their direct customer without further knowledge about the specific sector, as visualized in figure 9.

Figure 9 shows how the sector-specific supply chain is easily expendable for KPN. For every sector, KPN collaborates with the specific technology suppliers and gives their expertise about connectivity, while most of the time KPN doesn't fully understand the operative market. As mentioned in paragraph 1.1 KPN strives to make multiple sectors more sustainable by providing sustainability. However, as said in paragraph 2.3, to make the whole sector more sustainable it's most efficient if all stakeholders of the supply chain change to a sustainable business model. Therefore, the supply chain should change to an ecosystem for continual innovation, which is visualized in figure 10.

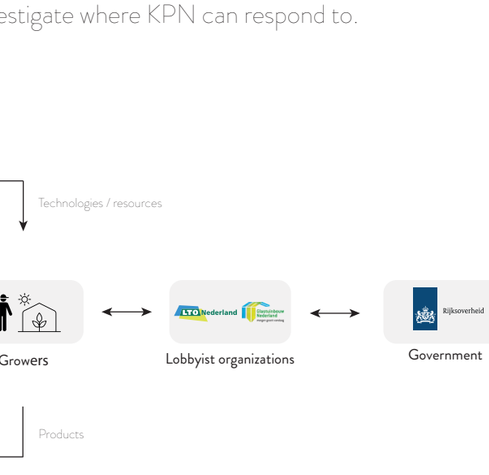


Figure 10: Horticultural's ecosystem for continual innovation (Adapted from Geissdoerfer, Bocken & Hultink, 2016).

To create this ecosystem of figure 10, every stakeholder needs to have a clear market understanding to keep the uncertainty as small as possible, as said in paragraph 2.4. Therefore the wall between KPN and the market needs to fade away, to create an ecosystem for continual innovation. To make this wall fade away it's important for KPN to not only understand their customer but also understand the other stakeholders within the ecosystem. In the next paragraph, the future trends are analyzed to investigate where KPN can respond to.

Figure 9: Sector broad approach of KPN (own illustration)

4.1.2 Most important trends in the Dutch horticulture

To get a better overview of the context a DESTEP analysis is conducted. A DESTEP analysis provides more information about the context, the Dutch horticulture. The DESTEP analysis consists of six different topics: Demographic, Economic, Social, Technological, Ecological, and Political (Vliet, 2020).

Demographics	The horticultural sector is the largest sub-sector in agriculture of the Netherlands measured by economic size (CBS, 2021).
Economic	Consumers are willing to pay more for sustainable products (Yang, 2017). However, the product margins are still very low, this makes it difficult for farmers to be more sustainable and profitable at the same time (Bekkem & de Vries, 2020).
Social	Compared with other agricultural sectors all around the world, the Dutch greenhouses are seen as an example based on their sustainability and productivity (World Economic Forum, 2019). The Dutch horticultural sector wants to keep this leading position, which leads to an increasing pressure to keep innovating (Stichting Kennis in je Kas, 2019). Besides that, there is a negative image against chemical crop protection from society, which leads to a continuous pressure to keep decreasing pesticide usage (Stichting Kennis in je Kas, 2019).
Technological	Growers having an innovative mindset, and are open to adapt to new technology which helps them to become more sustainable (Glastuinbouw Nederland, 2021).
Ecological	Dutch horticulture is a frontrunner in sustainability (World Economic Forum, 2019). While Dutch horticulture is preparing the next step to don't use natural gas anymore, Brussel still considers natural gas as a sustainable fuel (Weijer, 2021). However, the Dutch government strives to decrease the amount of natural gas used and to be even more sustainable (Stichting Kennis in je Kas, 2019).
Political	Lobbyist organizations are in consultation with the government about sustainable horticulture, to collectively set sustainable goals and get financial support when needed (Glastuinbouw Nederland, internal analysis).

The increasing pressure is an opportunity for KPN. When KPN is aware of all future regulations and needs of the growers, KPN can respond to the need of the sector by developing innovations. To know the current situation of how KPN is currently included in the market, the next paragraph gives an elaboration of an internal analysis of KPN and its role in the current horticultural market.

4.2 KPN in the horticultural sector

KPN is the client of this project, therefore it's important to look towards the research question from their perspective. The research question, mentioned in paragraph 2.5 is: How to set up an ecosystem for continual innovations to increase the sustainability potentials of a sector? Based on different internal conversations with KPN employees, it can be concluded that they already have the impression that they are already collaborating within an ecosystem. To verify these conversations the next paragraph gives an analysis of how these ecosystems are created, what sort of ecosystem these are, and what the threats and opportunities are for KPN in the Dutch horticultural market.

4.2.1 KPN's IoT innovation funnel

To explore new markets and innovate, KPN set up the Open Innovation Hub, such as the agricultural market. Within this Open Innovation Hub, KPN investigates new trends and new partners to collaborate towards innovations. To develop innovations, KPN collaborates with other companies, suppliers, startups, and universities to dive into new value propositions. By these new collaborations KPN focuses on their motto: "business first, technology second". Business first notifies the importance of the market needs, where the solution needs to be beneficial for all stakeholders. Figure 11 gives an overview of the process from idea to go-to-market from IoT solutions of the open innovation department of KPN. The innovation process of KPN has four different phases: Explore, validate, execute and scale.

The first phase is the explore phase. Within this phase, the first contact is starting with potential customers or partners. These contacts start in three different ways, by technology scouting of potential start-ups, by contacting prospects based on personal contact of KPN employees, or by talking about other potential technologies with partners/customers. In this phase, KPN looks for collaborations that are mutually beneficial for all stakeholders and contribute to a certain market need. For KPN this benefit is mostly business value, where the solution needs to be profitable or create a marketing value to increase their trustworthiness in a (new) sector. When all stakeholders see business benefits from technology, the collaboration is pushed to the second phase.

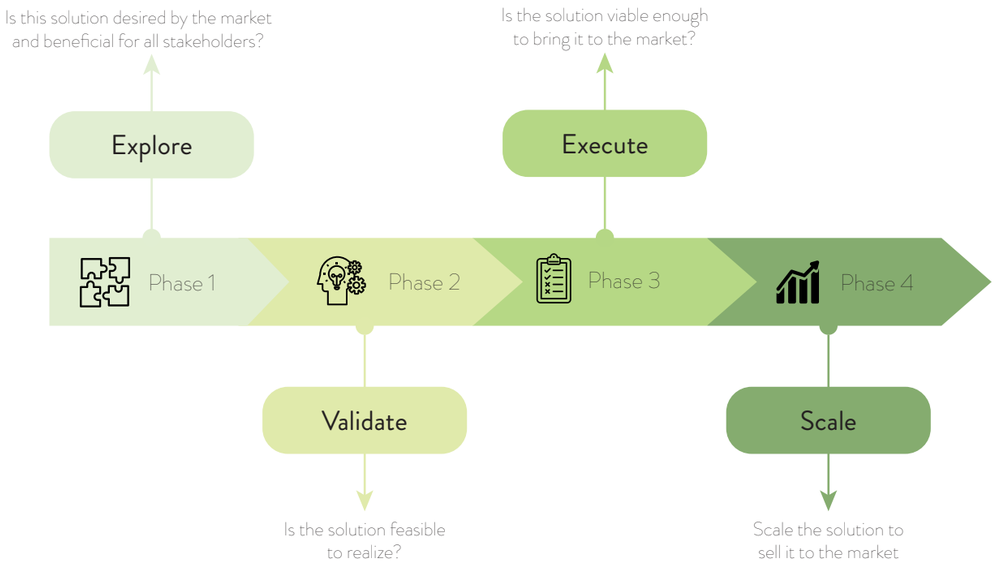


Figure 11: Innovation funnel of IoT of KPN (own illustration)

The second phase is the validation phase, where the validation of the concept and ecosystem is placed centrally. A proof of concept is made to test the solution, and multiple conversations between all stakeholders take place to identify the problem solution and solution market fit. Within this phase, it's important that the proof of concept is tested successfully and every stakeholder identifies their role within the ecosystem. In all current ecosystems, the role of KPN is to provide the connectivity for the solution. When all stakeholders see the potential of the solution and the proof of concept is tested successfully, the solution can continue to the third phase.

The third phase is the execute phase. Within this phase, the solution is tested as a minimum viable product within the context of use. For Dutch horticulture, this context of use is a functional greenhouse that is not only created to test innovations but is owned by a professional grower. In this phase, mostly other stakeholders are testing the solution, because they can integrate faster than a large organization like KPN can do. Within this phase, there is a soft product launch into the consumer market. For horticulture, a soft launch can be mouth-to-mouth publicity by growers, publicity within trade magazines, or a news report. When the solution is viable enough, it continues to phase four, where the big go-to-market launch takes place.

The goal of the last phase is to scale the solution where the solution has a big go-to-market launch. One stakeholder of the ecosystem promotes the solution to the market. For IoT solutions in horticulture, KPN doesn't take much publicity with the launch of the solution. Mostly the hardware provider of the ecosystem launches the IoT solution. This stakeholder was chosen because they have the highest trust within the market. Nevertheless, while KPN does the publicity launch, the go-to-market launch is done by the commercial business department, which is another department than the Open Innovation Hub where the first 3 phases take place.

In all four stages, KPN focuses on business benefits and selling their connectivity. Connectivity has been their core business for the last 150 years, and this will stay their core business. By working together with other stakeholders who are more specialized in the specific sector, there is a stronger end product or service, because the whole ecosystem understands the market needs and problems of the end-user. However, with this approach, it is more difficult for KPN to get an in-depth understanding of the context, problem, and end-user. This results in a less solid strategy to enter the market and a possible problem where KPN can't foresee who to collaborate with to reach the biggest business potential. By getting knowledge about the innovation process, it isn't clear yet how KPN is currently involved in its ecosystems. Therefore, examples of current ecosystems are needed to analyze what type of ecosystems KPN is currently operating in.

4.2.2 KPN's horticulture IoT solutions

A couple years ago KPN started to enter the agricultural market in the livestock sector. When this didn't work out the way KPN expected, KPN entered the arable market and the horticultural market. To get a better understanding of the arable market, KPN contacted growers in place, dived into this network to get a real understanding of the market.

For the horticultural market, KPN wanted to gain insights by joining the 'club van 100' of the Wageningen University & Research (WUR). The club van 100 is an innovative network of companies and researchers to improve the horticultural market.

Almost all members of the club van 100 were already closely involved in the sector and already have high expertise in this sector. However, KPN does not have high expertise in the sector, therefore other members were a bit hesitant by the participation of KPN within this sector. To identify what KPN learned from the solutions which are already in place, two examples are described which are all in a different phase of the innovation funnel. To realize these solutions, KPN needs to elaborate on an ecosystem. To refer back to paragraph 2.4, figure 12 gives an overview of the solutions and the sort of ecosystem they are in.

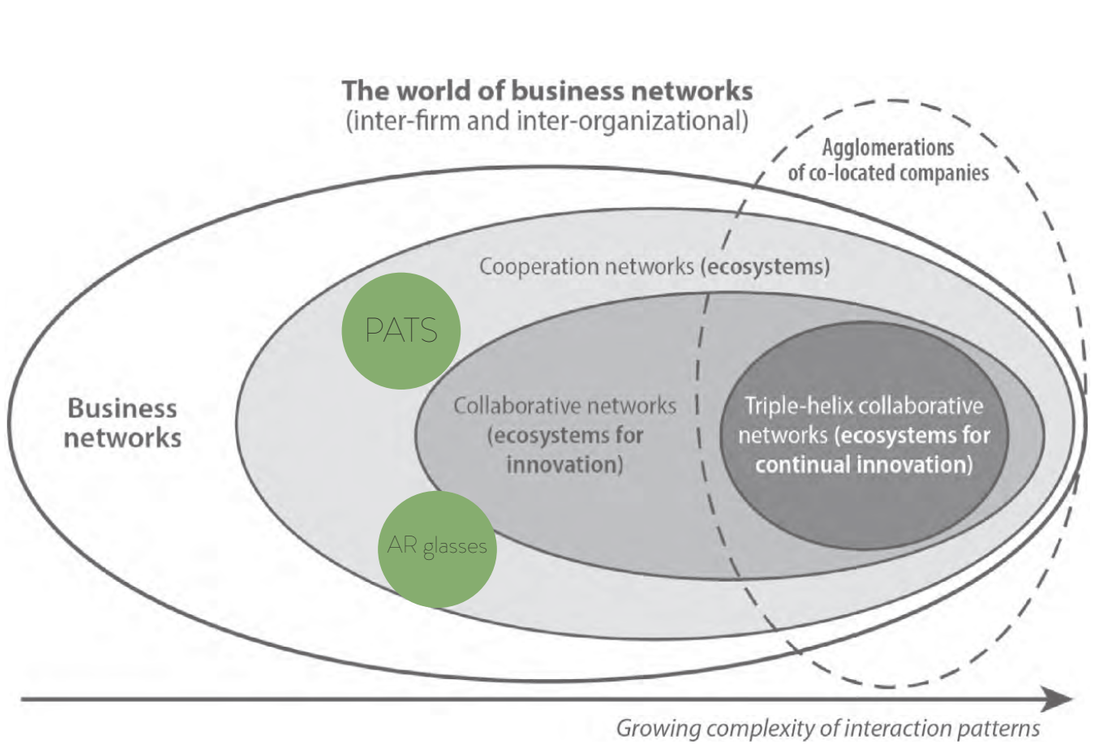


Figure 12: Different KPN IoT solutions sorted by sort ecosystem (adapted from Russell & Smorodinskaya, 2018)

Understanding plants via Augmented Reality

An example case which is in the second phase is the project of Augmented Horticulture, which is initiated by a research project of the Wageningen University & Research (WUR) and has started in 2019. This solution is augmented reality (AR) glasses that help untrained personnel of growers by knowing which flower is ready to harvest (Balendonck, 2020).

This prevents harvesting flowers that are not ready yet, so these don't have to be wasted and the experienced grower doesn't have to invest their time by teaching new growers. This project started as a research project of the business unit Horticulture of the WUR in collaboration with multiple entrepreneurs such as Syngenta Seeds, Florensis, LetsGrow.com, Itelligence, Mprise, and KPN (Balendonck, 2020). The current ecosystem is visible in figure 13.

AR glasses were bought by Microsoft, which is currently known as the HoloLens 2. Besides that, there are different suppliers with different roles within this ecosystem. The WUR is the research initiator and asked other entrepreneurs to add

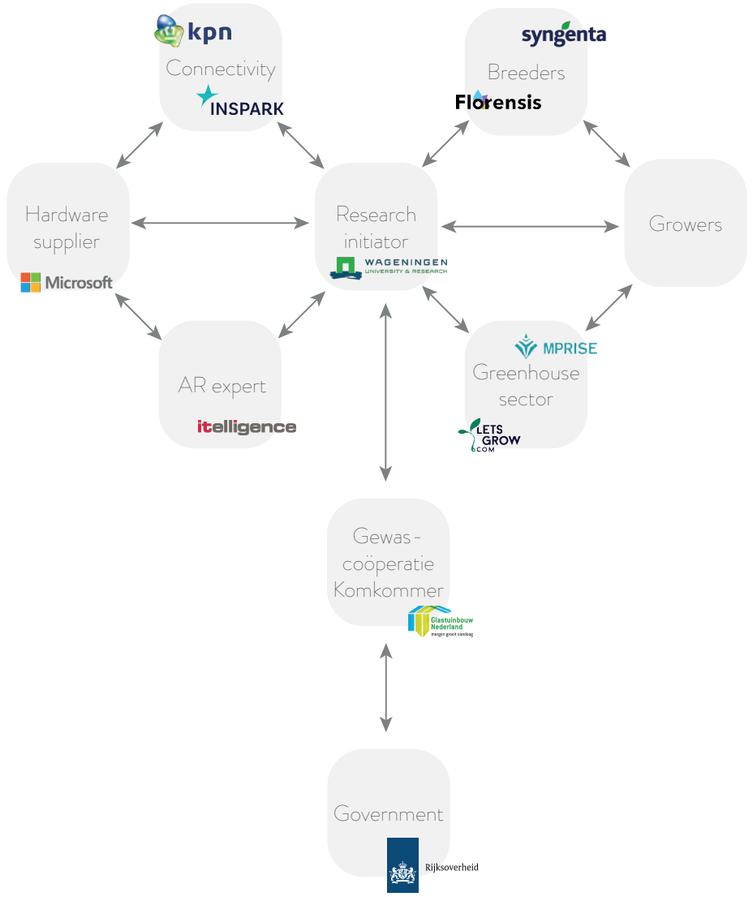


Figure 13: Ecosystem of AR-glasses solution (own illustration)

value to this solution by adding product knowledge as the breeders (Syngenta and Florensis), adding market knowledge (LetsGrow.com and Agriware), and adding IT solutions such as connectivity and AR experience (Intelligence and KPN). Recently Gewascoöperatie Komkommer has been connected within the ecosystem. Gewascoöperatie Komkommer is part of Glastuinbouw Nederland, which represents the sector to the government.

Within this ecosystem, KPN provides its network and hopes to learn more from the sector. To be more specific, KPN's subsidiary, Inspark, is mostly involved in this project. Inspark is a subsidiary which is specialized in digital transformation with Microsoft technologies. Within this project, KPN is mainly collaborating with Microsoft and the WUR. There are meetings with all stakeholders of the ecosystem, however, within these meetings, the WUR is the initiator, and all other stakeholders add value wherever they can.

This ecosystem can be seen as a cooperation network, where different organizations work together towards one certain solution or activity. As shown in figure 13 the WUR is placed in the center of the ecosystem and collaborates with all stakeholders. This ecosystem is specifically used for this one solution, and therefore not labeled as an ecosystem for continual innovations. To evolve this ecosystem towards an ecosystem for continual innovations, all stakeholders need to collaborate and exchange value. By entering this ecosystem KPN hoped to get more knowledge of the horticultural sector and increase their brand awareness within the sector. However, within this ecosystem, KPN isn't directly talking with all stakeholders or at least the growers. KPN is mainly talking with the WUR and Microsoft, which results in still no market knowledge and no in-depth information on the need of growers. Within this ecosystem KPN learned that only talking about connectivity is too broad for other stakeholders, therefore Inspark is more included to configure their role of connectivity within the specific solution from Microsoft and make it tailor-made for the horticultural sector.

PATS

Another example case of KPN within the horticulture sector is called PATS, which is currently in phase three, execute, of the innovation funnel of KPN. PATS is a start-up founded in 2016 by 2 students of the TU Delft and 1 student from the Erasmus University Rotterdam. The idea started with a mini drone that removes insects from the sky by its propellors (de Haan, 2019). PATS saw the opportunity for this application within horticulture because of their problem with mots. These mots are laying eggs within the crop of the grower, which could lead to damage to the crop and the disability of selling their crop. Nowadays, growers use pesticides to fight the insects, but because of sustainability reasons laws don't allow growers to use that many pesticides anymore (de Haan, 2019). To make the solution viable within greenhouses, there are 20 drones needed per greenhouse. The drones communicate with the control systems around the greenhouse, when a control system detects insects, one of the drones gets a signal to remove the insect out of the air within a few seconds. The ecosystem of PATS is shown in figure 14.

PATS is the biggest player in this ecosystem because PATS is doing almost everything by itself. PATS talks with the growers about their needs and uses the connectivity of KPN to connect their drones. This solution is still in the third phase and is not yet scaled and sold by many growers. With this solution, KPN and PATS learned that it's still hard to enter the horticultural market because they are a new player. Most growers buy their technologies from their current suppliers. Therefore it's hard to sell this new technology. PATS doesn't have the status of a trustful big supplier yet and also has a smaller business network in the horticultural sector, which turns out to be important with scaling the solution. Seeing this problem, KPN isn't the best partner, because they also don't have a trustful big supplier status and don't have a big business network within this sector.

The ecosystem of PATS can be seen as a cooperation network, where different organizations work together towards one certain solution or activity. PATS is collaborating with all different stakeholders, while KPN only collaborates with PATS. The same can be concluded as in the ecosystem of the AR-glasses, it's a simple ecosystem where KPN misses the opportunity to learn from the sector, and show their brand within this market, besides only a logo on the product.

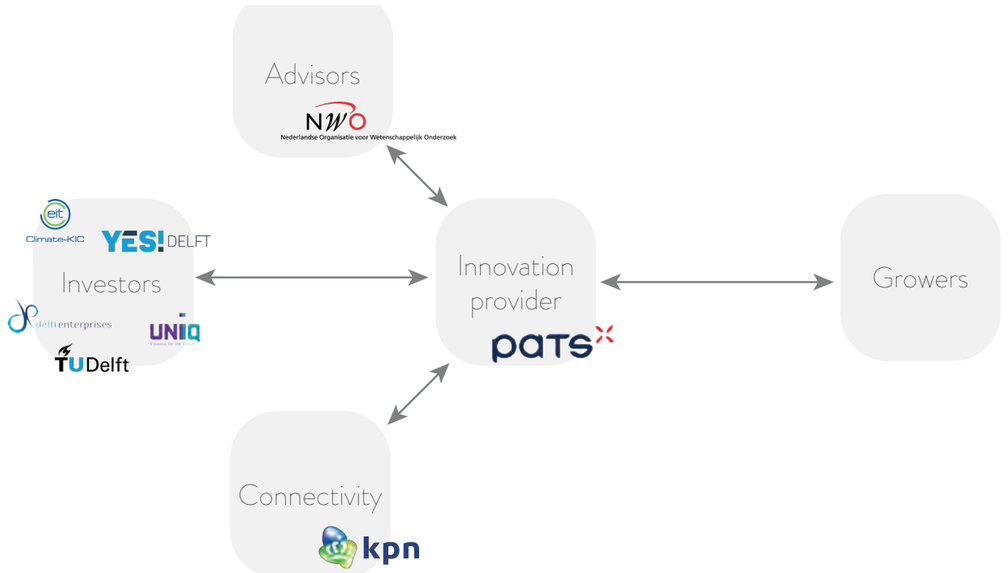


Figure 14: Ecosystem of PATS (own illustration)

4.2.3 Conclusion

From this analysis, it can be concluded that KPN is good at the first two ecosystems which are elaborated in paragraph 2.4. Employees of KPN have a big business network, which leads to a lot of connections with people from other companies. However, to enter the horticultural market, their business network isn't specific enough, which could be a threat for KPN which makes it harder to enter this market. Until now, KPN uses their current connections to collaborate for a specific solution, collaborated in the form of a simple ecosystem for one specific solution. The brand image of KPN also helps with the creation of a simple ecosystem. KPN is seen as a trustful brand and partner (Jong, 2019). Therefore, other organizations are more likely to collaborate with KPN than with other Dutch telecommunication companies.

However, with their current ecosystems, KPN can't make a difference because they don't have enough impact. KPN hoped to learn more by their collaboration in different ecosystems and learn more from the horticultural sector. While KPN participated in these ecosystems, KPN also focussed on the arable sector and the livestock sector. Which resulted in general participation, where KPN didn't learn the needs and problems of this sector. As mentioned in 2.4 to enhance the sustainability potential of the Dutch horticultural sector as a whole, it's most efficient to work together in an ecosystem of continual innovation as visualized in figure 10.
To be able to create this there needs to be a clear understanding of the need of the market. Therefore the next paragraph elaborates on the needs of the growers.

4.3 Growers' perspective

As said in paragraph 4.1, Dutch greenhouses are the most sustainable and productive agriculture in the world. The Dutch horticultural sector wants to keep this leading position.

To get more knowledgeable about the growers' perspective, five different growers with different crops are interviewed. Different demographics are chosen, to get insights regarding different perspectives. Figure 15 gives an overview of the interviewees.

	Sort crops	Area of the greenhouses	Years of experience	Location of greenhouses
Interviewee 1	Peppers	19 hectares	31 years	Middenmeer
Interviewee 2	Flowers	11 hectares	121 years (as family)	Westland & Heinenoord
Interviewee 3	Plants	0,5 hectare	50 years	Westland
Interviewee 4	Tomatoes	100 hectare	7 years	Westland
Interviewee 5	Tomatoes	12,5 hectares	44 years	Westland

Figure 15: Overview of interviewees (own illustration)

These interviews were conducted while using a semi-structured interview (see interview guide in Appendix A). The goal of the interviews is to understand the growers' perspective towards the research problem: *How to successfully launch sustainable IoT solutions in the horticultural sector?*

The subgoals of these interviews are to:

1. Know which problems they are facing in their greenhouses
2. Get to know why they adopt technology to help them
3. Get to know the barriers which they see of adopting technology
4. Get to know their opinion about the sustainability aspects of their greenhouses
5. Get to know how technology can help them be more sustainable

To identify these subgoals, the interview is divided into four themes: The greenhouses, technology in the greenhouse, sustainability, and technology & sustainability. The results of the interviews are analyzed by adopting a grounded theory approach. The interviews are converted into abstract codes to investigate the general process, theory, or interaction based on the view of the interviewees (Creswell, 2008). All interviews are recorded and transcribed, to focus on the conversation as an interviewer. Afterwards, the final codes are clustered (see figure 16).For the detailed categorization of the final codes see figure 17. To give an overview of the insights gathered during the interviews, this paragraph provides insights based on the subgoals.

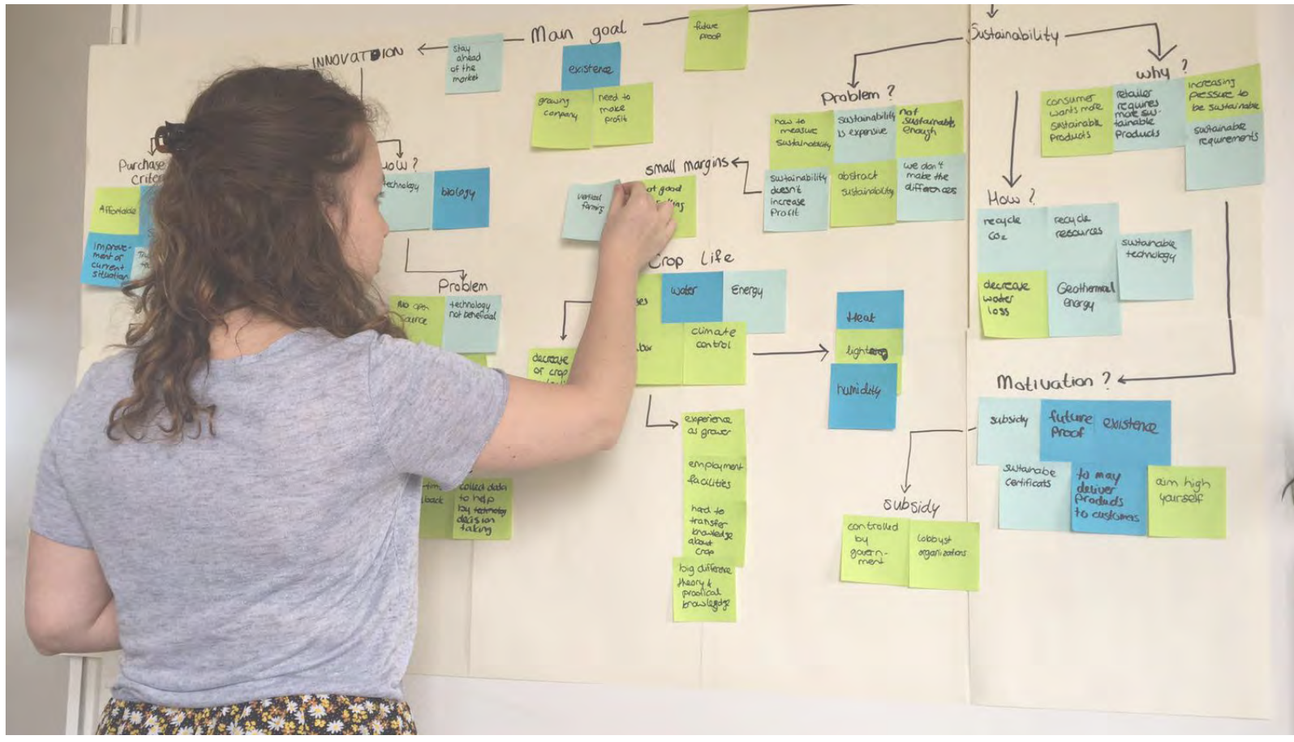


Figure 16: Clustering the codes (own illustration)

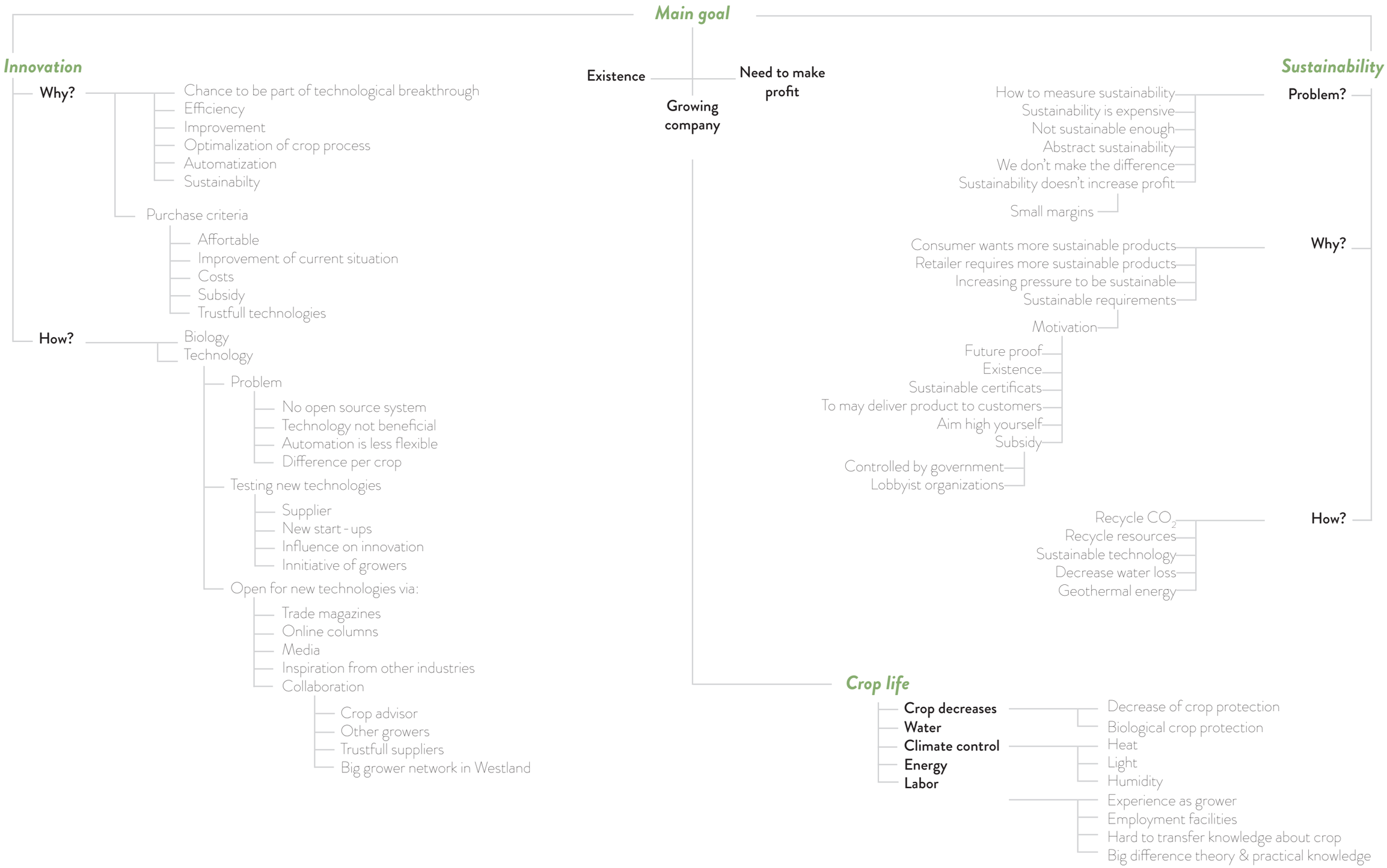
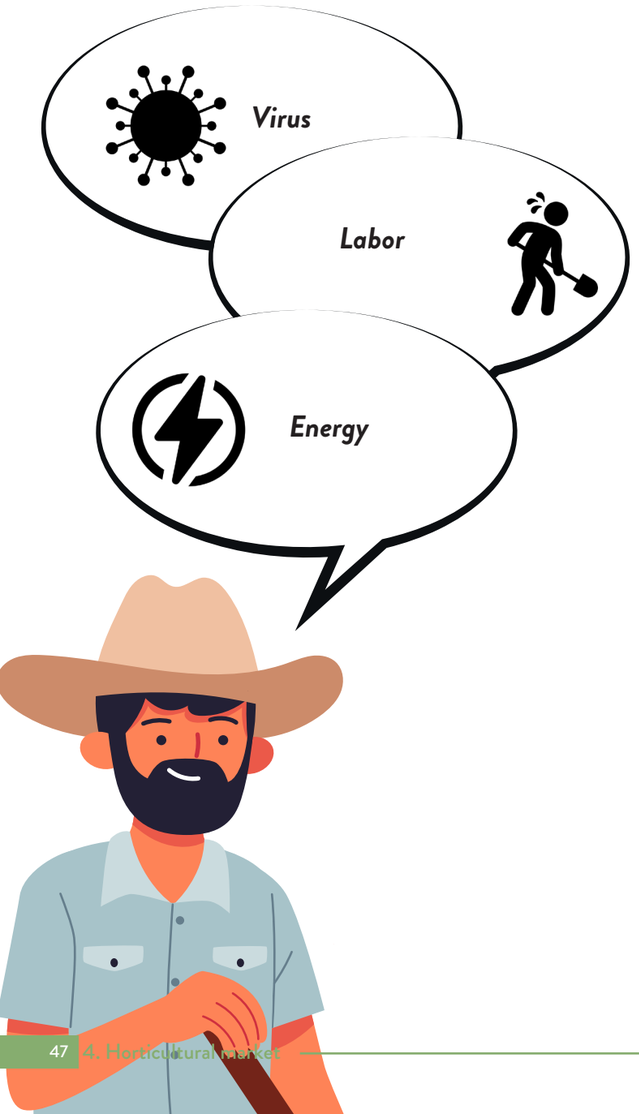


Figure 17: Detailed categorization of the final codes (own illustration)

4.3.1 Problems within their greenhouses

From the perspective of the growers, from all different crops, there are some major current issues. These are the decreasing amount of allowed crop protection in combination with the increasing amount of upcoming viruses, labor in the greenhouses, and energy costs. The decreasing amount of allowed crop protection is a big problem according to different growers. The allowed amount of chemical crop protection is imposed by European Commission in Brussel.



However, suppliers and wholesales set their requirements based on the allowed amount of chemical crop protection of the European Commission.

"According to legal requirements, an x amount of residues of crop protection may remain on my products, but then supermarkets are saying: we only want half or a quarter of these residues... I will not get a better price for my products with less crop protection, but otherwise, I may not deliver to these retailers."

For labor in the greenhouses, it's difficult for growers to be able to pay the increased salaries while the prices for their products need to be produced for the same price. It's also hard for growers to teach new employees how to grow. This is a big problem for growers in areas where there are a lot of greenhouses, especially in Noord-Holland. However, in the Westland, growers experience this labor problem too.

"It's becoming more difficult to afford good labor. Labor is becoming scarce and the costs increase... the basic salary increases, which makes it more expensive for us to be able to produce tomatoes for the same price."

Energy is a problem because energy is becoming more expensive over the years. This is combined with the fact that in the future, government and lobbyist organizations require growers to only use sustainable energy. Currently, all growers use cogeneration, where they use gas to generate electricity. This cogeneration has an efficiency of 95%, where powerplants generally only have an efficiency of 60%. Some farmers are collaborating with powerplants to let their cogeneration function as energy storage during energy decline. Growers also have solar panels to gain green energy, which can be stored in their cogeneration and can be used when needed. This all shows how sustainable energy is already important to growers. Another solution for sustainable energy is the use of geothermal energy. Geothermal energy is initiated by one grower, which is expanding its network with more growers. However, this is not an affordable option for all growers yet. Growers also see a big opportunity to expand their energy network not only with other growers but also with their surroundings to help everyone to be more sustainable.

"Now, for example, Shell would also like to participate. It also has leftover heat and must also meet climate requirements... in this way we can absorb the excess heat from it, and then use it again. I also see the opportunity to also connect residential areas... Everyone has to get off the gas, and then this is a great opportunity. "

4.3.2 Adopt new technologies

There are different reasons for growers to determine whether or not to adopt new technologies in their greenhouses. The biggest reason to purchase new technologies is to improve their current situation. All growers want to stay ahead of the market, by keep innovating. Growers have an innovative mindset, and therefore really open to new technologies. However, their greenhouses are their business, so technologies can not only be an improvement for their crop process but also need to be financially affordable. They can't innovate by themselves and therefore keep ties to their technology supplier. Whenever growers want to improve something, their current supplier is the first stakeholder they will express their needs too.

"We strongly believe in a good relationship with our supplier, together you can innovate. We help suppliers by delivering our problems and they help us by developing for our problems. Then you make each other strong... We would much rather work with an existing supplier to develop something new than to think along with all kinds of new developers to invent the wheel again."

Whenever an innovation is created, growers have three main criteria: affordability, improvement, and trust. Affordability and improvement are created by talking to their suppliers to identify their needs and budget. Trust is created by testing the innovation in a greenhouse. As one of the interviewees said:

"It needs to be tested in practice, then there is no other way than testing it in the greenhouses, where the production takes place, instead of in such a test greenhouse, because that is not proving anything."

Growers are in a big network, where if one grower adopted a technology other growers will be quickly informed about this technology. The adaptation of this technology will be really fast if this innovation is provided by an already know supplier within the horticulture. However, for new technology suppliers, this could be more difficult to scale, because they are new in the sector and therefore is harder to get adopted by the growers.

4.3.3 Barriers of technology

The barriers are corresponding with the reasons to adopt technologies. The biggest barriers are improvement of the current situation and affordability. If the new technology isn't an improvement and/or isn't affordable, growers will not adopt the technology. Therefore it's needed to

understand the problem of the growers, to be able to make a proposal which improves their current situation.

"I'm open to trying new technologies, however, if it turns out that the technology isn't improving my process then the supplier can pack his bags, go home and do his homework again."

4.3.4 Sustainability

Growers see sustainability as the theme of the future. All growers are passionate about their company and see the need to be more sustainable to maintain the right to exist. They all say that everything needs to be more sustainable, but that they already made big improvements in the past few years.

"Sustainability is a theme of the future, so if you don't do anything with it, you will lose the right to exist."

All growers feel the pressure to be more sustainable because their product suppliers and wholesales demand more sustainable products. Therefore a conflict is created because while their customers want more sustainable products, growers do not get more profit from them. However, if growers don't meet the requirements of their supplier, they may not deliver their products. This overlaps with the problem of the decreasing amount of pesticides that are allowed.

"The customer is demanding sustainability and we just have to comply. That is fine, but it will cost us a little bit more money. So there the challenge occurs: Where do you go along with your customer and where do you not go along with them?"

Another problem of sustainability is how to measure it. Some growers measure it based on energy usage or resource usage. Others are focused on certificates such as 'on our way to planet proof', 'MPS-GAP' or 'SQ', to show their customers how sustainable they are. Nevertheless, it's still hard for them to show precisely how sustainable they are.

"I know that there are different measurement systems, but sustainability is still too broad of a concept."

To become more sustainable it could help them to make it more affordable. In the current situation, the government is subsidizing different sustainable initiatives and technologies, however, even with these subsidies, it's still not affordable for a grower to invest in sustainability and therefore not realistic to become more sustainable. Growers see the costs as the biggest barrier to become more sustainable. They all see the need to become more sustainable and feel the pressure of society and their customers. However, in the current situation sustainability isn't rewarding, it's required to have the right to exist. This makes it hard for them to become more sustainable, because the price of their products stay the same, while growers pay more to produce sustainable products. If growers get more profit out of sustainable products, they all easily become more sustainable.

"If the government gives a sustainability subsidy, it's easier to become more sustainable. We all want a cleaner planet, but we also want our company to exist. So then you have to find kind of a middle ground, where the government can help, to speed up some sustainable innovation."

4.3.5 Technology which helps being more sustainable

There is no direct technology that helps growers grow more sustainable. Nevertheless, almost all technologies are indirectly helping to be more sustainable. Currently, technologies help with optimizing the crop process, which decreases the number of needed resources, which is more sustainable. Examples of these technologies are spraying trees, LED lights, and climate control. These technologies help growers to only use the resources which are needed to optimize their crop.

Their future need is to optimize their crop process even further. By knowing exactly what every plant needs, it's easier for the grower to only give the resources which are needed to let their crops grow as efficiently as possible. To realize the technology for this need, there needs be a combination of expertise of growers and technologies.

"We are increasingly growing "remotely". This means that we are making more use of technology. With the upcoming technologies, we want to have insight into the computer very quickly, or real-time on my phone."

4.3.6 Conclusion

To conclude on the research question: *How to successfully launch sustainable IoT solutions in the horticultural sector?*, growers want to adopt sustainable IoT solutions if it's an improvement, when it's affordable, trustworthy, and long lasting. To achieve these four requirements it's important to understand their need. Currently, their current technology suppliers are most trustful and have the biggest chance of launching a sustainable IoT solution.

The biggest current need of growers is to get real-time feedback, to improve their crops' growing process. This need can be a big opportunity for KPN because they have experience in other sectors with monitoring real-time data. However, this technology needs to be tailor-made to be used in greenhouses and therefore needs more development. To develop this technology and launch this in the horticulture sector, it's needed to know how to position themselves on the market. Therefore a competitor analysis is done in the next paragraph to identify their market opportunities and threats.

4.4 Competitors of technology in the horticulture

To map out the competition of smart farming within horticulture the five forces of Porter's model is used (Porter, 2008). Porter's Five Forces analysis is developed by Michael E Porter in 1969. Porter's model aims to evaluate the competitive position of an organization, by looking at its position and strength compared to the market (Mwenemeru & Nzuki, 2016).

The model is based on 5 forces: supplier power, buyer power, competitive rivalry, the threat of substitution, and the threat of new entry. By learning about the impact of these powers, the model can identify strengths and weaknesses, to avoid mistakes by entering the market (Mwenemeru & Nzuki, 2016). Supplier power assesses the impact of the suppliers, which identifies their power to raise their prices. The buyer power assesses the impact of the buyers and identifies their power to lower down the prices. Competitive rivalry is identifying the threat by the current competitors of the current market, with competitors who sell the same product and services. The threat of substitution identifies the threat of customers who switch to other products/services which meet the same needs. This could influence the power of the suppliers and also the temptation of the market. At last, there is the threat of new entry, which identifies the attractiveness of new entrants entering the current market. Which is identified by the barriers to enter the market, and the potential profitability of new entrants (Mwenemeru & Nzuki, 2016).

Within this competitor analysis, the competition of KPN is analyzed based on the growers' need to innovate to be more sustainable. Porter's five forces of this field are visualized in figure 18.

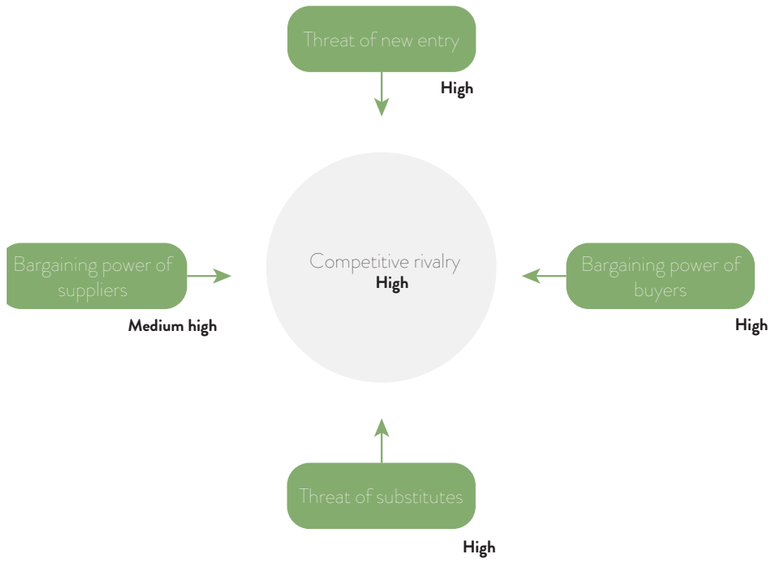


Figure 18: Porter's 5 forces model (Adapted from Mwenemeru & Nzuki, 2016).

4.4.1 Competitive rivalry

Growers are continuously looking at technologies that can enhance their productivity and increase their sustainability. If they look into new technologies, their first source of technology is their current technology supplier. Growers prefer their current supplier because all technology systems can be connected and whenever there is a problem there is only one stakeholder which they need to contact.

If this technology supplier uses connectivity to connect their products, then telecommunication companies occur in the supply chain. In the Netherlands, there are three providers: KPN, Vodafone, and T-mobile. All three providers are active in the B2B market and launched connectivity for IoT solutions in the last years. Compared to T-mobile, KPN has a competitive advantage which is that they are already active in the field of agriculture. What makes their trustworthiness in the field higher. However, Vodafone also provides solutions in the field of agriculture which could be a threat for KPN. Vodafone uses NB-IoT for the communication of IoT, while KPN uses a LoRa network that is not licensed to let IoT be connected. For the customer, this could be perceived as less safe, because this network isn't licensed. A competitive advantage that KPN has created over the last year is that they do not only provide connectivity but also sell the decoding of the data to their customer. In this way, the customer doesn't have to translate his data into useful insights but can read the useful insights directly. KPN sells this decoding platform to overcome commodity rivalry, to be only judged by the cheapest provider. Nevertheless, if Vodafone also is selling this decoding, the selling point is still by cheapest price. Therefore KPN needs to be active within the market, to listen to the desires of the market to keep ahead of the competition.

In the current situation, KPN is dependent on the market demand of technology suppliers. Whenever a technology supplier develops a technology wherefore connectivity isn't needed, KPN is out of the picture. This could form a threat, where KPN is instantly excluded from the market. From which can be concluded that the competitive rivalry for KPN is high.

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4.4.2 The threat of new entry

The threat of new entry in the field of sustainable technology in horticulture is high. Besides that growers talk with their current suppliers about new technologies, they are also very open to new technologies of other suppliers which are trustful, affordable, and improve their current way of working. Big growers are open to test new technologies in their greenhouses. Whenever a (new) company comes up with a new technology, which fulfills the need of the growers, it will easily become a success. In the horticultural market, news about new technologies is spread very fast. Therefore the chance of upscaling the technology, while it's proven to work for one grower, is very big.

This ease of new entry could form a serious threat for KPN. Because this new entry knows how to fulfill the need of the growers, while KPN doesn't understand the market yet, so not understand the growers' needs and will never develop new technology by themselves. Then the situation is the same as with competitive rivalry, where KPN depends on the market demand of technology suppliers if they are needed. To be involved in all new technology, KPN needs to actively scout every possible new technology in horticulture. However, this isn't realistic for KPN, therefore it's even more important to understand the market and ensure to be part of an ecosystem for continual innovations to prevent instantly be excluded from the market.

4.4.3 Threat of substitutes

As mentioned in paragraph 4.3, the need of growers is to continuously collect data about their plants. This data is preferably collected for every individual plant. In this way, they know if this plant needs more or less light, heat, humidity or if it has insects on it. If they have this data, they could also give the plant input of light, heat, and humidity based on previous data. In this way, growers can optimize the quality of the product and only use energy that is needed, which is also sustainable.

To research into companies that could help them, they don't only look at technologies of their sector, but they also look at technologies of other industries. In for example manufacturing industries asset tracking are used to track the process of different product. These technologies are not accurate enough to track on centimeter specific, but technologies will develop. When these technologies become more accurate, and asset tracking is possible on this small scale, there is also a potential for horticulture. When this technology is developed, different big growers want to be part of this potential breakthrough. This will lead to different growers which are open to testing the technology.

This competition could form a serious threat for KPN. If their horticultural ecosystem isn't prepared to deliver this technology, there will come competition from companies such as IBM, Oracle, and Sensolus. Besides this threat, KPN could also see this as another opportunity, to actively work together with other ecosystems of other sectors where they are currently in towards this opportunity.

4.4.4 Bargaining power of buyers

The power of the buyers is high within the horticultural sector. The buyers in this case are the product suppliers, who sell their products to wholesalers and who sell eventually to the consumers. Wholesales want to increase their sustainability requirements, to meet the requirements of consumers who want more sustainable products. However, wholesale isn't paying more for products they purchase. Therefore product suppliers also don't pay more money for more sustainable products. On the contrary, if growers aren't more sustainable for the same product price, they may not deliver their products to the supplier, which will cost them even more. Growers don't have the power to influence this bargaining power of their buyers, therefore to change this situation growers need help from other authorities.

4.4.5 Bargaining power of suppliers

Viewed from the perspective of growers toward their suppliers, their bargaining power is relatively high. There are many technology suppliers which help grower, however, the barrier is high for a grower to switch into new technology with a new supplier. The main disadvantage of switching to another supplier is that this new technology of the new supplier can't communicate with the old technology, this is because the technology supplier is the owner of the data. Whenever a grower wants to integrate all technologies in its greenhouse, it's more convenient to buy everything from one supplier, which most of the time not affordable for a grower.

4.5 Main take-aways

Context of horticulture In the current situation there is still a linear supply chain. Which makes it hard for KPN to be included in an ecosystem for continual innovation. There is also an increasing pressure to be more sustainable as a sector. Where an ecosystem for continual innovation can be very beneficial to increase its sustainable potential.

KPN in the horticultural sector KPN is currently involved in some IoT solutions within horticulture. However, they are only involved in a simple ecosystem, because they are mainly talking with their direct customers. This is a missed opportunity to learn from the sector, and show their brand within this market, besides only a logo on the product.

Growers' perspective In the current situation sustainability isn't rewarding for growers, it's required to keep the right to exist. Therefore they will only become more sustainable if they need to or if it's increasing their profit. Besides that, growers are open to technology which helps them be more sustainable if it's affordable, trustful, and improves their current situation. The most important need they currently have is to get real-time feedback on the needs of their crop. This can be a big opportunity for KPN because they have experience in other sectors with monitoring real-time data.

Competitors of technology in horticulture KPN has a lot of strong competitors in the field of horticulture. KPN is currently dependent on the market demand of technology suppliers. Which forms a threat, where KPN is instantly excluded from the market. To increase their opportunities they need to actively create an ecosystem for continual innovation, increase their sector-specific knowledge and make themselves indispensable in the ecosystem.

To be determined next Now there is a clear understanding of the market opportunities and threats for KPN in the horticultural market. The next step is to create an ecosystem for continual innovations to be able to increase the horticultural sustainable potential. This leads to a design goal where a method is designed to set up an ecosystem for continual innovation, and strategic advice for an ecosystem for continual innovation for the horticultural sector specifically. The next chapter elaborates on this design goal.

05 Design goal and requirements

In the last chapters, insights into the horticultural market are collected. To increase the sustainable potential of the horticultural sector, an ecosystem for continual innovation needs to be created. To set up an ecosystem, there needs to be a clear understanding of the problem. Therefore this chapter will elaborate more on the problem statement of this project and the design challenge.

Content

5.1 Problem statement

To explain the design challenge of this project, first the concepts of 'problem as given' and 'problem as received' are explained. According to Heijne and van der Meer (2019), there is a difference between 'problem as given' (PAG) and 'problem as perceived' (PAP). The PAG is the problem where the design project is originally started, however, whenever this problem isn't the correct challenge anymore, the problem statement needs to be rephrased into the PAP. For this project, the PAG is defined in paragraph 1.3 as

How to successfully launch a sustainable IoT Solution in the horticultural sector?

Based on the gathered insights into the horticultural market in chapter 4, whenever KPN wants to launch a sustainable IoT solution in the horticultural sector, KPN needs to increase its sector-specific knowledge. Whenever there is more sector-specific knowledge, KPN is better able to evaluate its added value for this sector. Therefore the problem statement is rephrased to the following PAP:

How to apply IoT to improve the sustainability potential in the horticultural sector?

To increase the sustainability potential of a sector, paragraph 2.4 describes this as most effective while done with an ecosystem for continual innovation. To set up an ecosystem for continual innovation, as visualized in figure 10, there needs to be a clear understanding of the growers' problems. Therefore the next paragraph dives into the growers' problem.

5.2 Growers' problem

Based on the interview results of paragraph 4.3, there are three big problems growers are currently facing. These three problems are the decreasing amount of allowed crop protection in combination with the increasing amount of upcoming viruses, labor in the greenhouses, and energy costs. To overcome these problems, growers describe the need to optimize their crop process, increase the possibilities for remote growing, and for these solutions to be affordable so that their business can still be profitable. They all see the urge to deal with sustainability requirements, if they do not react to these requirements there is no right of existence for them in the future. By clustering the characteristics of the interviewees, two different personas of growers are created, these final personas are visualized in figure 19.

To identify how IoT can be applied to help them with their problems, the underlying sustainability problem is identified. As mentioned in paragraph 4.3.4 sustainability is a broad concept, which is still vague. The sustainability potential can always be improved because no standard validates if it's good enough. Therefore growers will ask themselves critically while making the decision when purchasing a technology to increase their sustainability potential: *"For how long will this solution be sustainable enough?"*. At the same time, there is a high pressure to innovate, because all needed resources to grow their crops are increasing in price, while the prices for their crops aren't increasing. Therefore growers will continuously ask themselves: *"Will this investment be worth it? Or will it be outdated in a few years?"*. Therefore there is constant pressure to keep innovating and keep improving without an end goal.

Teun

Owner of the family greenhouse

About

Age: 44
Region: Noordoost-polder
Years in the field: 32
Education: Higher vocational education in agricultural sector

Crops: Flowers
Status: Married
Children: Three

From an early age, Teun helped his father with the cultivation. After secondary school, he completed Horticulture & Agribusiness at InHolland University of Applied Sciences. After this, Teun took over the family business from his father. In his spare time, he spends a lot of time with his family but also enjoys a cold beer in the pub with his friends.

Daily tasks

- Monitoring the entire crops process.
- Purchase raw materials and plan the crop
- Managing production employees or team leaders.

Frustrations

- The high sustainable requirements from the supermarkets
- Lacking understanding of the government how to be sustainable as a grower

Wants

- Sustainable business for the next generations
- Real-time feedback from his plants
- Subsidy to make sustainable innovations more affortable

"By establishing a high-quality greenhouse, we can also grow a high-quality plant."

Gijs

Technology and innovation leader

About

Age: 31
Region: Maasdijk
Years in the field: 5
Education: Wageningen University & Research in Agro technology

Crops: Tomatoes
Status: Married
Children: One

Gijs grew up in 't Westland, surrounded by greenhouses. He decided to study in Wageningen, because of his interests in this beautiful sector. Now he is responsible for the technology and innovation within the greenhouse that he works. In his spare time, he is surrounded by family and friends, or enjoys sports activities, such as cycling and running.

Daily tasks

- Keep up to date with the latest technology developments
- Meeting with technology suppliers to discuss needs of the greenhouse
- Collect data from the crops progress to optimize the product system

Frustrations

- Increasing crop diseases
- High need for affordable and knowledgeable labor
- High energy prices

Wants

- Continual crops feedback, preferably plant-specific
- Sustainable options to continue in the horticultural sector

"The customer is demanding sustainability and we just have to comply. That is fine, but it will cost us a little bit more money."

Figure 19: Personas of growers (own illustration)

5.3 Design challenge

The goal of this project is to solve the problem as perceived: How to apply IoT to improve the sustainability potential in the horticultural sector?. IoT can be applied to automate the horticultural processes, which leads to reduced usage of resources, such as water, electricity, and pesticides, to increase the sustainability potential. However, this needs to be done in a way that also decreases the pressure of innovation and improvement without an end goal. Therefore the following design challenge occurs:

Design a strategy to innovate the horticultural sector durably.

an improvement of the current situation

which provide long-term benefits

Within this design goal, innovation is needed to improve growers' current situation, by for example decreasing the number of needed resources. While at the same time it's needed to do this durably to be able to adapt to the frequently changing sustainability requirements. Which can decrease the barrier for growers to invest in innovation, if it's guaranteed to be sustainable in the long-term perspective, instead of being outdated in a few years.

5.4 Design criteria

To develop a strategy that meets the expectations of growers, a few requirements and wishes for the design phase are developed. These requirements are based on the interview results of paragraph 4.3.

The solution must...

- Optimize the crop process by increasing the productivity of the greenhouse.
- Decreases the number of needed resources (water, energy, light, pesticides, etc.) to grow crops.
- Be affordable for a grower to purchase and implement.

The ecosystem must...

- Be beneficial for most of the stakeholders.
- Be created by stakeholders which should be able to add value to other stakeholders.

Besides these requirements, there are also some whishes developed to take into account while designing the strategy. These whishes are mostly focused on the ecosystem which should be created around the solution and is mostly based on the literature review about ecosystems of chapter 2.

The ecosystem must exist of stakeholder, which...

- Are open to collabore instead of compete
- All exchange values with every other stakeholder.
- All have complementary skills.
- Are open to listen to end users' needs, to create a customer-facing solution.
- Are open to look towards the short-term and long-term perspective of the collaboration.

5.5 Main take-aways

Problem statement The problem that was given at the beginning of the project was: "How to successfully launch a sustainable IoT Solution in the horticultural sector?". After the research phase, this problem is converted into the problem as perceived: "How to apply IoT to improve the sustainability potential in the horticultural sector?"
Growers' problem To identify how IoT can be applied to help them with their problems, the underlying sustainability problem is identified. Their biggest problem is that there is constant pressure to keep innovating and keep improving their sustainability potential and efficiency without a clear end goal.
Design challenge The goal of this project is to solve the problem as perceived. The design challenge derived from this goal is to design a strategy to innovate the horticultural sector durably.
Design criteria To develop a strategy that meets the expectations of growers, a few requirements and wishes for the design phase are developed. These requirements are to increase the productivity of the greenhouse, decrease the number of needed resources, and that the solution needs to be affordable for a grower. Besides that, the ecosystem which creates the solution needs to be beneficial for most of the stakeholders and all stakeholders need to add value to other stakeholders.
To be determined next Now there is a design goal formulated, the design phase can start. In this design phase, a solution needs to be created to innovate the horticultural sector durably, where IoT is applied to improve the sustainability potential in the horticultural sector.

06 Design development

In chapter 5, the design goal to design a strategy to innovate the horticultural sector durably is formulated. This design goal is the starting point of the design phase.

The design phase starts with a diverging phase which includes idea generation, which is done by a creative session. The ideas which are generated from this session are converted into clusters, to translate these clusters into idea cards. From these idea cards, 3 concepts are developed which are discussed with different people from KPN. Based on these discussions and the list of requirements of paragraph 5.5, one concept is chosen.

Content

6.1 Idea generation

6.1.1 Goal

The goal of this phase is to generate as many as possible ideas based on the previous research of chapters 2 - 4. The chosen method to generate these ideas is a creative session with multiple IDE students who have a different perspective than KPN.

6.1.2 Method

Three students from IDE were asked to participate in the brainstorm session. There were two students from the master Strategic Product Design and one student from the master Design For Interaction. Besides that, there were enough post - its, pencils, flipchart paper, and one circularity card deck of Konietzko, Bocken & Hultink (2020) available. There were also materials printed for the introduction of the session, to make it easy to look back during the session. Also, a time estimation was given to give the participants an overview of the activities and time estimation. The creative session is divided into four parts: introduction, warm - up, idea generation, and clustering. See the visualization of the process in figure 20.

Creative session

1. Introduction (10 minutes)
    - » Introduce Gijs & Teun
    - » Introduction of the problem
2. Warm - up (5 minutes)
    - » Playing the expert
3. Idea generation (40 minutes)
    - » Circularity deck workshop
4. Clustering (5 minutes)

Figure 20: Creative session agenda (own illustration)

In the introduction part, participants got 10 minutes to make themselves familiar with the topic. For this introduction, the focus was mostly on the growers' perspective. This perspective is chosen to give KPN ideas that are more focused on the needs of the end consumer than on business potential. The materials to introduce participants to the topic can be seen in appendix B. These materials include two growers' personas showed in figure 19, a simplified overview of the needed resources crops need to grow, the supply chain of figure 8, and the real problem which is described in paragraph 5.2.

After the introduction of a warm - up exercise, 'the expert' is done to create an open mindset, which focuses on possibilities instead of roadblocks. For this exercise, one person was assigned the expert. After that, two people suggested two different nouns which were combined to a new product. Examples of the new product which were created in the session were: Tesla bicycle tires and pencil clouds. Then the expert needed to sell this new product to the group within 30 seconds. The exercise is done 8 times, so every person was the expert two times. By doing this exercise participants got the confidence to let them feel an expert without having a lot of knowledge about the topic.

After the warm - up session, the rules, sort of brainstorm, and problem statement for the session are explained. The rules for the brainstorm were that there are no bad ideas, ideas don't have to be realistic and the aim is to create many ideas. After the explanation of the rules, the problem statement combined with the explanation of the brainstorm was explained. The problem statement was: "How can we help Gijs and Teun making their greenhouse and sector more sustainable". To give the participants some directions, the principle of Konietzko, Bocken & Hultink (2020) is explained. To innovate towards a circular economy in ecosystems, organizations can use five connected strategies: Narrow, Slow, Close, Regenerate and Inform (see figure 21). The narrowing can be done by using fewer products, energy, or components. Slowing down can be done by extending the use of the product, components of materials. The closing strategy stimulates users and/or organizations to close the circle and bring the waste back into use. Regenerate introduces the activity to recreate a natural ecosystem to use renewable energy or materials into the product, materials, or components. The last strategy, inform stimulates the use of technology which uses data to support the circularity of the innovation (Konietzko, Bocken & Hultink, 2020). From every category two or three cards are chosen to ideate with (see figure 21, or for further details see appendix C). Every participant gets eight minutes to ideate the problem statement combined with one strategy. After eight minutes the strategies switch and the participants should brainstorm about the next strategy. This is repeated until every participant brainstormed about all strategies.

After the idea generation phase, the participants were asked to cluster the ideas. For this phase, the participants were asked to take all post - its from the flipchart paper and read the ideas out loud to discuss with each other which clusters were formed. It is chosen to also include this cluster phase in the brainstorm, to get a reflection moment for the participants and give them the opportunity to talk about their thoughts on the creative session and the problem statement.

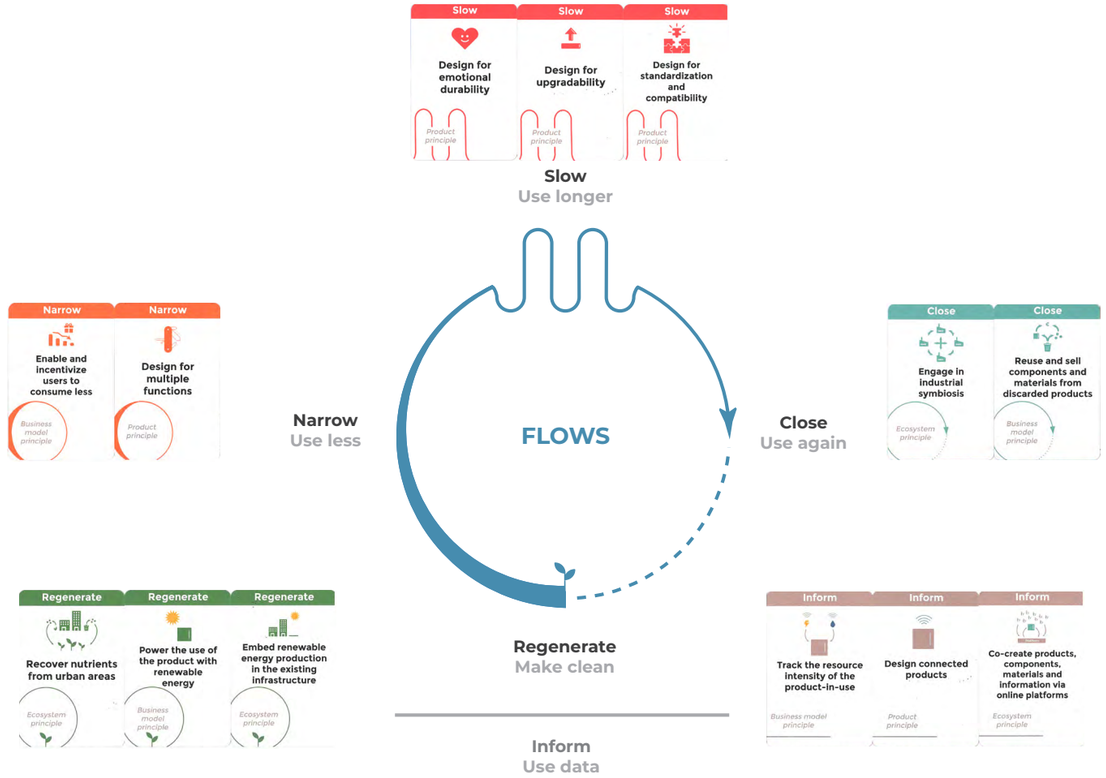


Figure 21: Five connected strategies and used cards during the creative session (Konietzko, Bocken & Hultink, 2020)

6.1.3 Results

During the creative session 114 ideas were generated (see figure 22 & 23)

Figure 22: During the idea generation (own illustration)

Afterward, all ideas were divided into twenty different clusters. While making these clusters, different subjects were coming up (see figure 24). At first, how underrated the grower is, seen from a consumer perspective. This resulted in multiple clusters which were focused on educating the consumer on the sustainable agriculture of Dutch greenhouses. Another topic that was discussed was the collaboration of the supply chain. Where during the session the participants became aware of how high the pressure was on growers, while growers have way less influence on the sector than desired.

Make products special Sustainable products need to be made special to let consumers know it's sustainable or local, which could increase the awareness of the consumer.
Involve the consumer actively Playful actions to involve the consumer in the growing process of the crops. For example by giving the consumer a plant to adopt, which they could follow from seed until it's ready for sale.
Standard technology Sell solutions that can be converted to other industries when it is outdated for the agricultural sector.
Education Educate the consumer by promoting 'Kom in de Kas' also in the more urban areas of the Netherlands to give them insights into the process of their food in greenhouses.
Awareness Make the consumer more aware of what sustainable products cost. By for example showing on the label which resources the tomato got to grow and how much every resource cost.
Gijs & Teun to power Include growers more in the process of technology development and give them more power over the prices of their crops.
Less technology By providing less technology energy can be saved which is more sustainable, whereas biological solutions don't need that much power to operate.
Seasonal products Only produce seasonal products, to stimulate the consumer to eat more sustainably.
Collaboration Collaborate more with other stakeholders of the supply chain to become sustainable as a whole sector and share the costs.
One technology for everything Have one technology or one platform that can do everything, so there are not multiple technologies that do all different things.
Make technology human Give technology the human knowledge of the grower, so there is less labor needed.
Governmental influences Give the government more knowledge on how they can work together with the growers to become more sustainable, and not only subsidies on what the government thinks is sustainable.
Services Create more services for growers, so new technology which increases the sustainability potential isn't a big investment for them.
Entertainment Use the light soiling of the greenhouse as entertainment for the environment.
Monitoring the greenhouses Use more monitoring technology to learn what crops need to optimally grow without unnecessary greenhouses.
Multifunctional greenhouses for products Use the heat of the greenhouse to also grow other products that need heat, for example, mushrooms.

Figure 23: The end result of the idea generation (own illustration)

Figure 24: Clustering the ideas (own illustration)

Multifunctional greenhouses for entertainment Use the heat of greenhouses as entertainment for consumers, by for example have a restaurant. To engage people more with the process inside a greenhouse.
Don't be afraid for outsiders Sell the not sellable crops to for example a petting zoo, to avoid throwing crops away which are rejected.
Collaborate for resources Collaborate with the neighborhood for resources. Let consumers use the residual heat from greenhouses and use the waste of consumers to create electricity from biomass.
Solar energy Let all technologies use solar energy, to decrease the amount of needed gas.

After all these clusters were made, it was still hard to get an overview of all ideas. Therefore the ideas are easily visualized to create an overview.

6.2 Idea visualization

6.2.1 Goal

The goal of this phase is to visualize the ideas which were created during the creative session. This process instead makes it easy to compare all ideas with each other and get a quick overview of the ideas.

6.2.2 Method

After the idea generation, clusters were made to merge all overlapping ideas. However, these 20 clusters were still hard to compare, because all clusters existed of four to twelve post-its. Therefore smaller clusters were made, with one title, as shown in figure 25. Some clusters remained the same, and some clusters were divided into smaller clusters. All these clusters are translated into idea cards. These idea cards all exist out of a title, a describing drawing, and some more explanation. This is all done in the same fixed-format on A5 paper, to made them easily comparable.

6.2.3 Results

All clusters were first clustered on different A5 papers, before visualizing them (see appendix D. Afterward, all clusters were converted into idea cards, which are shown in figure 26.

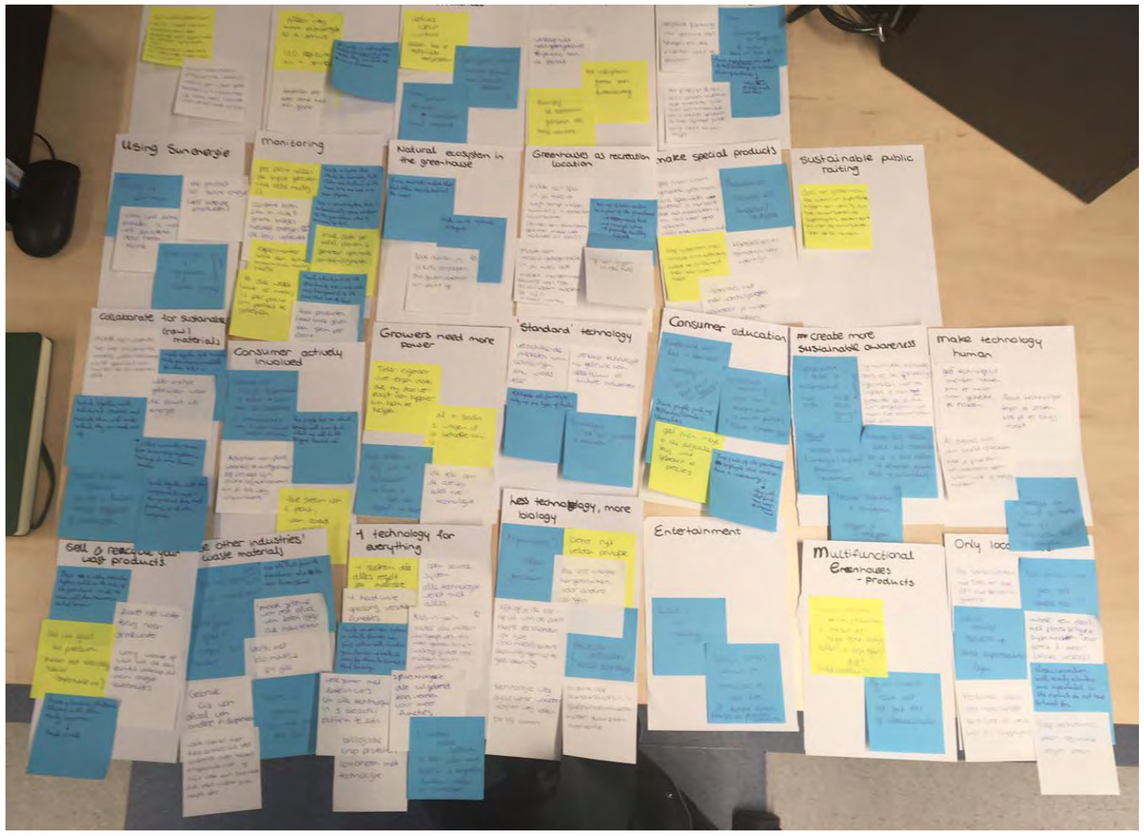


Figure 25: Smaller cluster cards (own illustration)

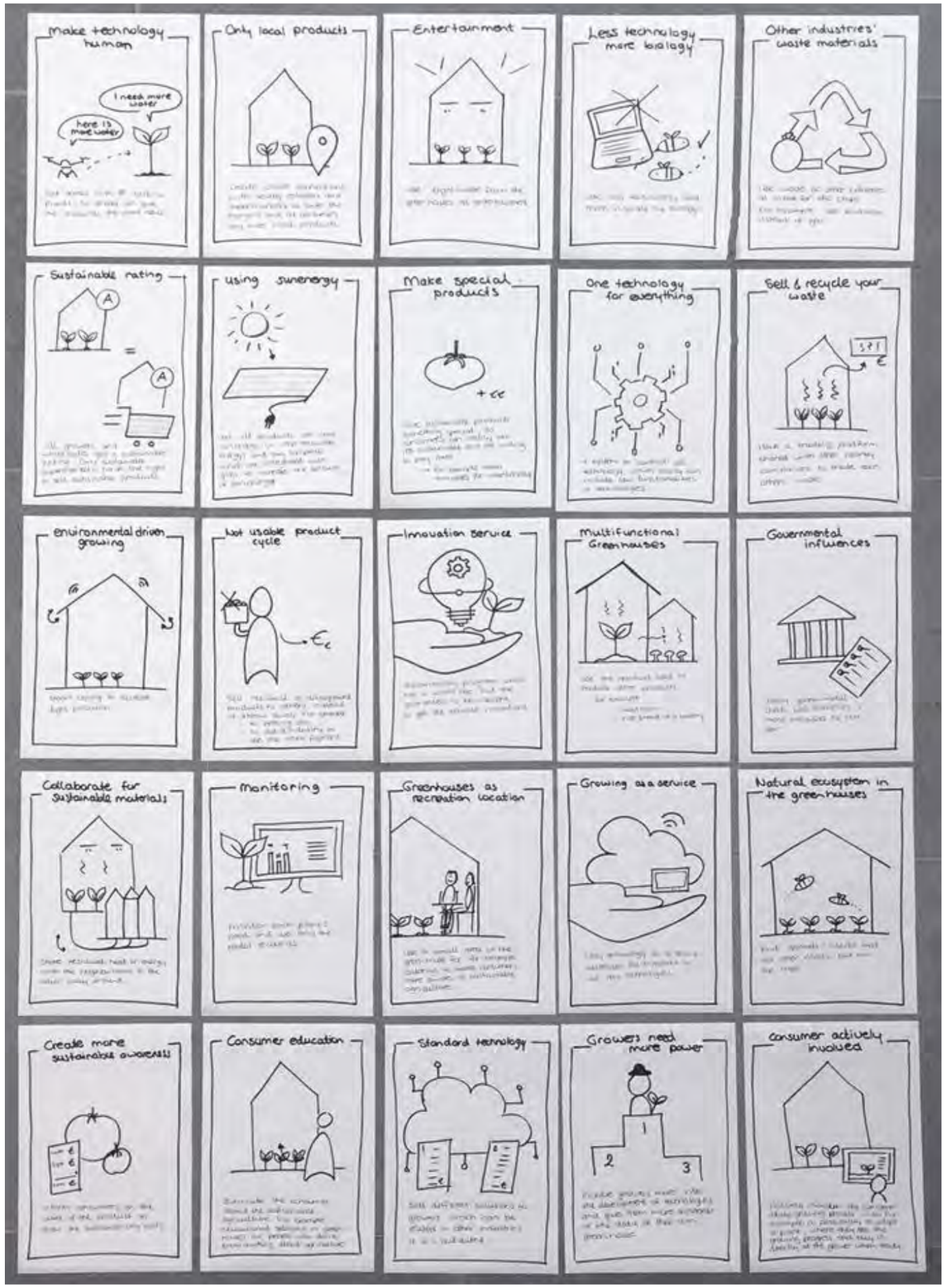


Figure 26: Idea cards (own illustration)

6.3 Conceptualization

6.3.1 Goal

The goal of this phase is to develop different concepts based on the idea cards which were made in the previous phase. These concepts needed to be more concrete than the idea cards and let them be self-explanatory to be able to present them to people at KPN.

6.3.2 Method

To make concepts, different idea cards were combined into a concept. This concept is developed in a fixed format, which contains a title, short description, visualization of what it will look like, the development steps divided into three timeframes, the advantage for the grower, and possible partners for KPN (see appendix E). The first version of the concepts was discussed with Jeroen Cox, company mentor and senior Strategic Lead Energy & Environment of KPN. After this discussion, the concepts were elaborated more thoroughly.

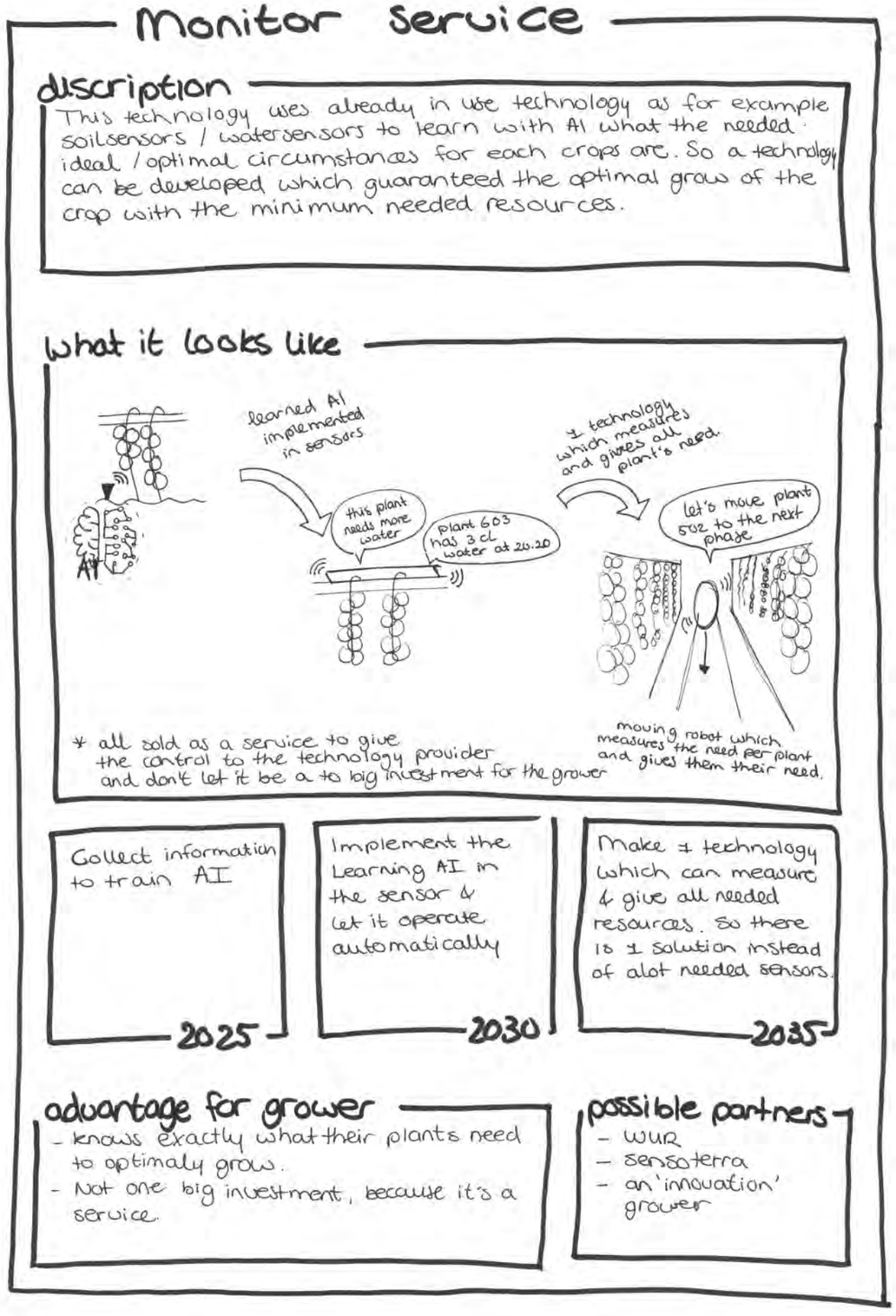


Figure 27: Concept 1; monitor service (own illustration)

6.3.3 Results

Concept 1: Monitoring service

The concept, figure 27, is based on the idea cards of figure 28. The monitoring service is an advanced monitoring service that helps growers know exactly what their crops need to optimally grow. The monitoring service is a service that includes sensors that will learn by artificial intelligence (AI) the need of the crop. Nowadays, growers don't have enough data to know what the exact effect is of the given input. For example, if growers give a crop 3 centiliter of water, the result will be visible in 8 weeks. Therefore AI needs to be trained to know the ultimate standards. When the AI is trained the next step of digitalization can start, where the crop is constantly monitored to know exactly which resources are needed at that moment for an optimal growing process. In the last phase, the monitoring service can know what every plant needs and can also operate automatically. For example, a robot can be used to monitor which resources the crops need, and can also provide the crop with more water, light, or other resources if needed.

The sustainability potential increases by only using the needed resources. This leads to a decrease of resources, where nowadays more resources can be used which are not absorbed by the crops. The concept is beneficial for the growers because they can save resources and it's affordable for them, because they don't have to make a big investment at once, but they can pay a monthly or yearly fee. To make this concept realistic KPN needs to work together in an ecosystem with partners who have at least experience in AI, who make sensors, a grower who is open to let AI learn their crop process.

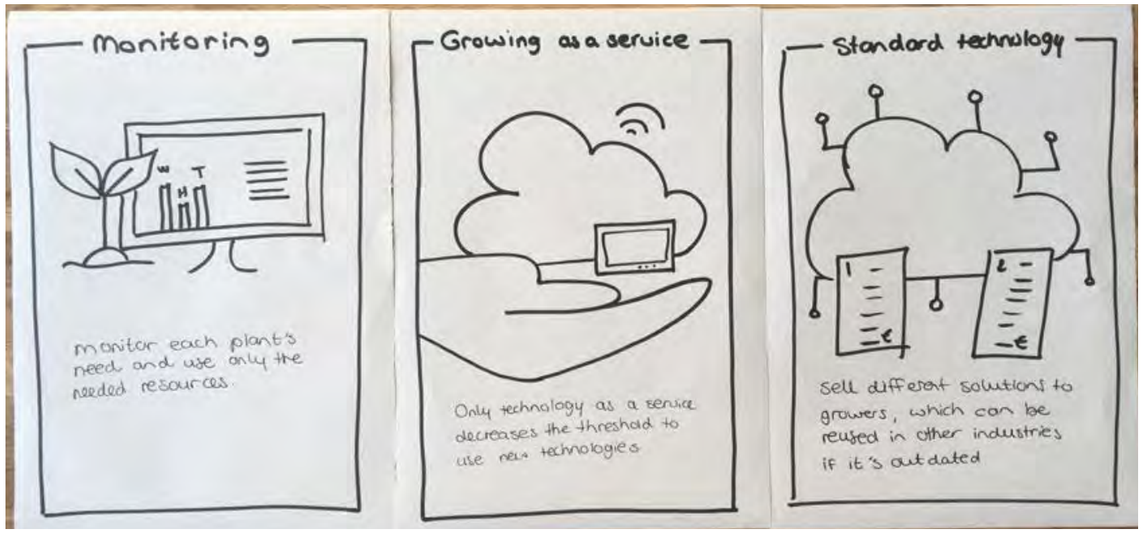


Figure 28: Idea cards of concept 1 (own illustration)

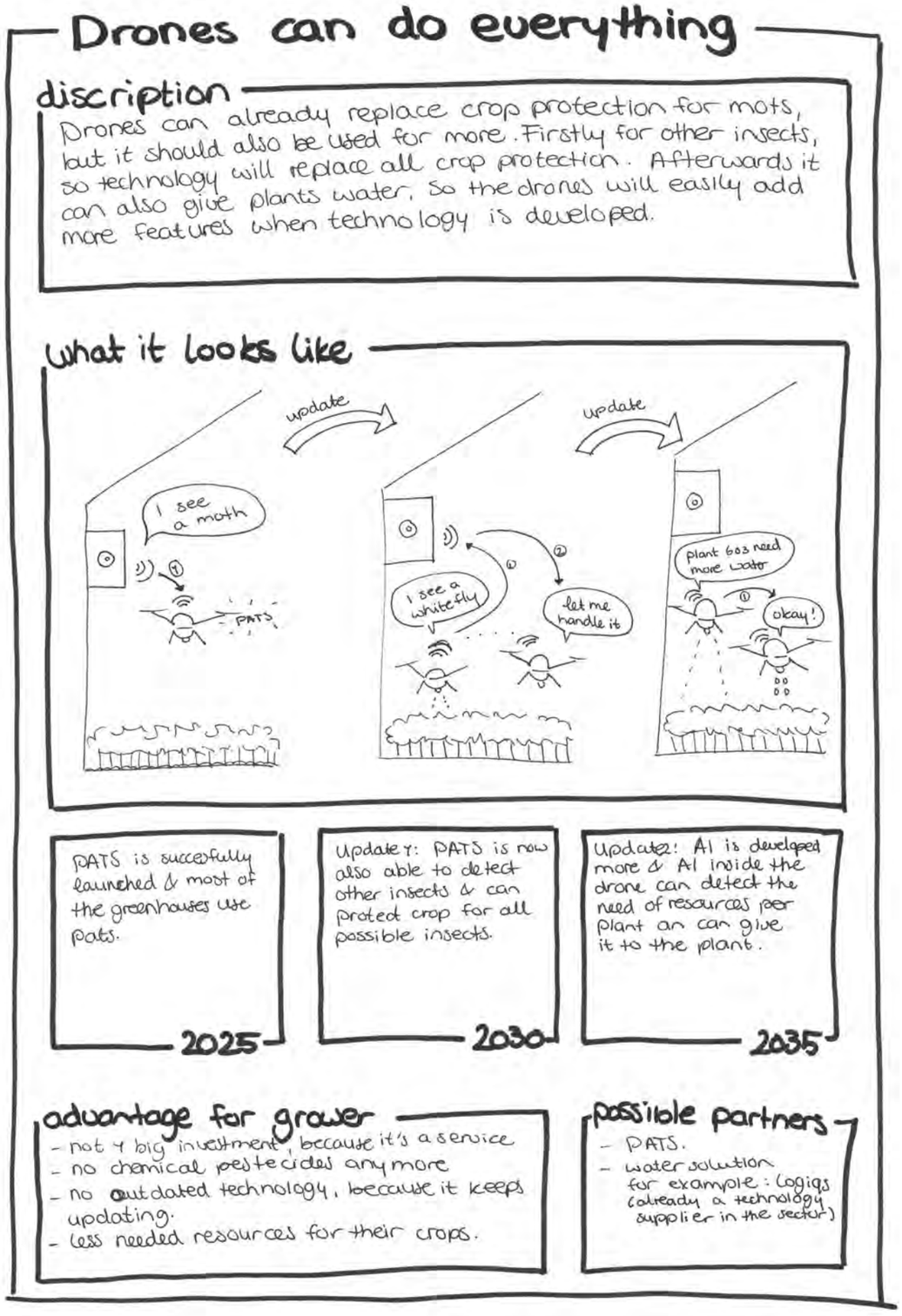


Figure 29: Concept 2; drones can do everything (own illustration)

Concept 2: Drones can do everything

The concept, figure 29, is based on the idea cards of figure 30. Drones can do everything is based on PATS, which is explained in paragraph 4.2.2. However, in the current PATS drones can only tackle mots, wherein this concept PATS made an extension. After the first update, PATS can spread pheromones which create sexual confusion by the diseases to stay away from the crops. Every insect has a specific pheromone which it releases, to change the behavior of other organisms. So by using pheromones, diseases will stay away from the crops without using chemical pesticides. Whenever all diseases are monitored and tackled by the drones, PATS can extent to other tasks for example provide water to crops.

The sustainability potential increases by decreasing the chemical crop protection to zero, by only using technology and biology which is reliable. The concept is beneficial for the growers because they don't need to use any chemical crop protection anymore, and because the drones get an update every time new technology is developed, there is no outdated technology that should be replaced. Also, this concept is provided as a service, which can make it easier affordable for growers, because they don't have to make one big investment. To make this concept realistic KPN needs to work together with PATS, but also with other stakeholders to make this solution easily scalable. These possible partners can be water solution suppliers, such as Logiqs, and biological experts in the field of horticulture such as Koppert Biological Systems.

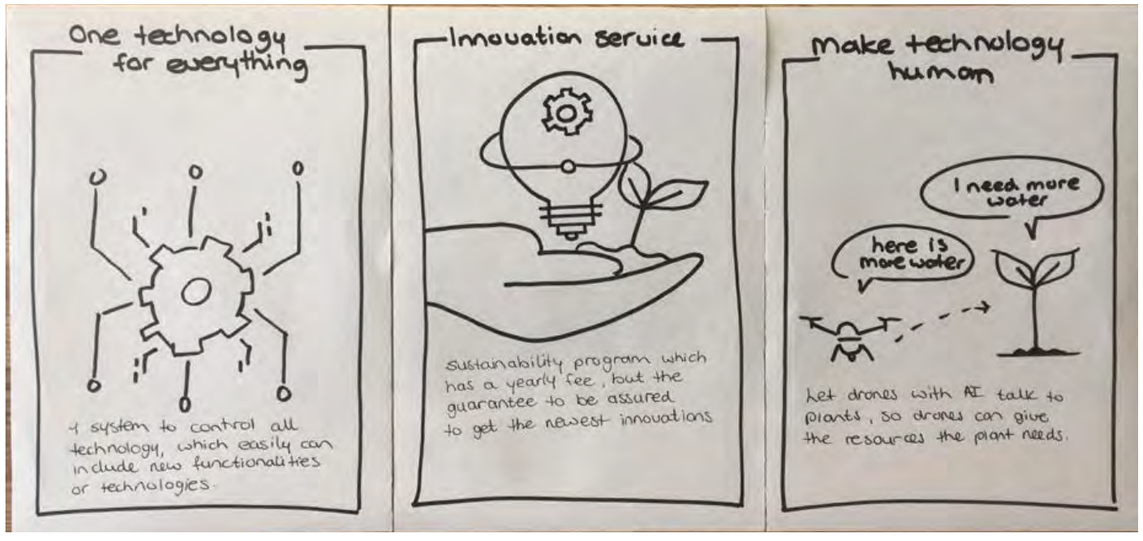


Figure 30: Idea cards of concept 2 (own illustration)

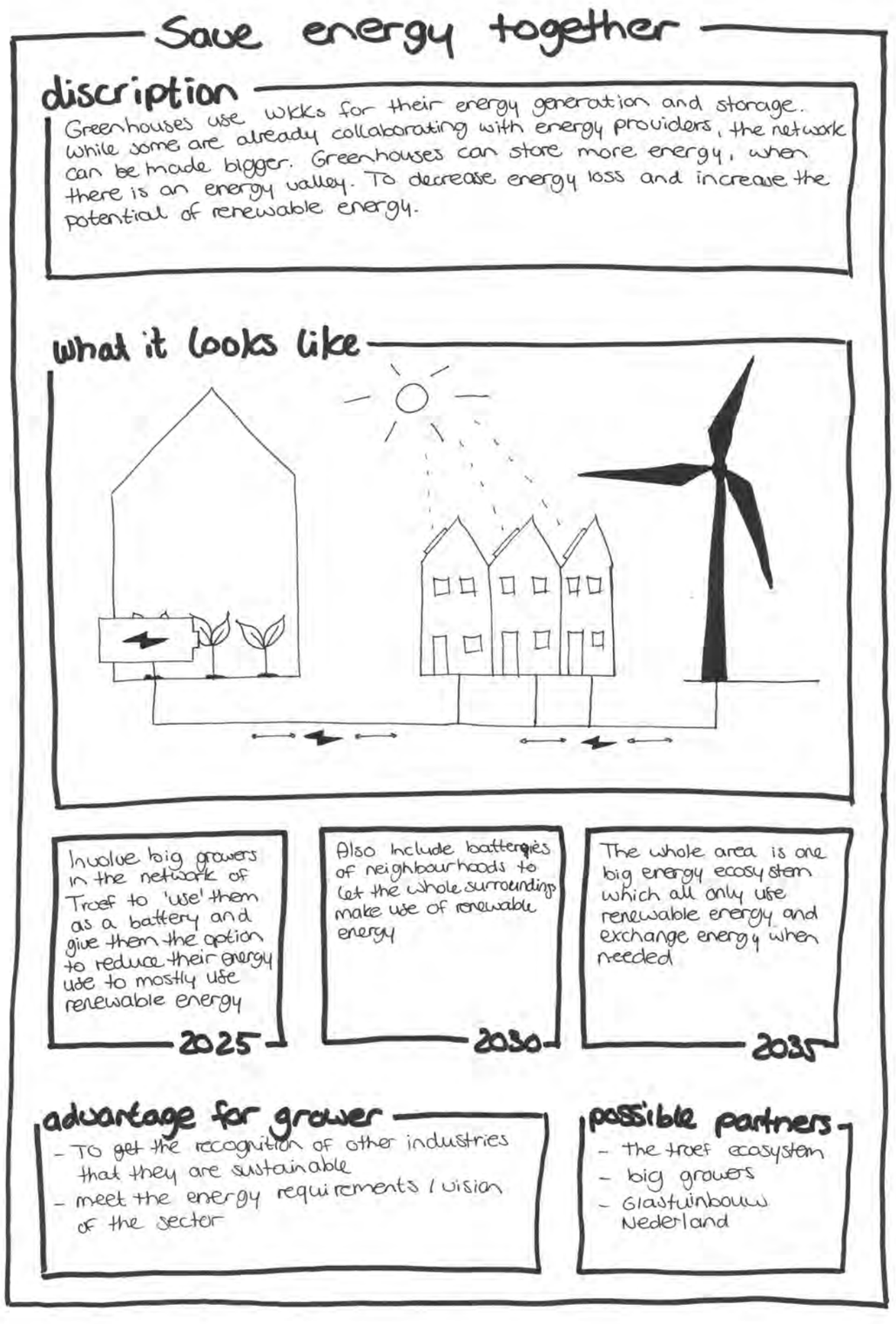


Figure 31: Concept 3; save energy together (own illustration)

Concept 3: Save energy together

The concept, figure 31, is based on the idea cards of figure 32. Save energy together is developed based on the increasing pressure to only use renewable energy in the future. Currently, KPN is developing a concept called TROEF, which is also called the internet of energy, where different stakeholders work together towards an energy system that is beneficial for all end users. When the sun shines and all solar panels generate more energy than used, energy can be saved. When there is a renewable energy decline, this energy can be used so no renewable energy is getting lost. Because growers have big cogeneration machines in their greenhouses, they can add value to this network of TROEF. In this concept, there is no renewable energy that gets lost and growers can sell their remaining energy/heat to their surrounded neighbors.

The sustainability potential increases by giving the cogeneration machines a second purpose when growers can't use them anymore to regenerate gas. Besides that, the concept is stimulating greenhouses and the neighborhood to work together and only use renewable energy. The concept is beneficial for growers because their remaining energy isn't wasted, it will promote their sustainable recognition by the consumers of that area and growers can in this way meet the energy requirements of the government. To make this concept realistic KPN needs to make an extension on their current ecosystem of TROEF with growers who are open for collaboration and Glastuinbouw Nederland to include more growers.

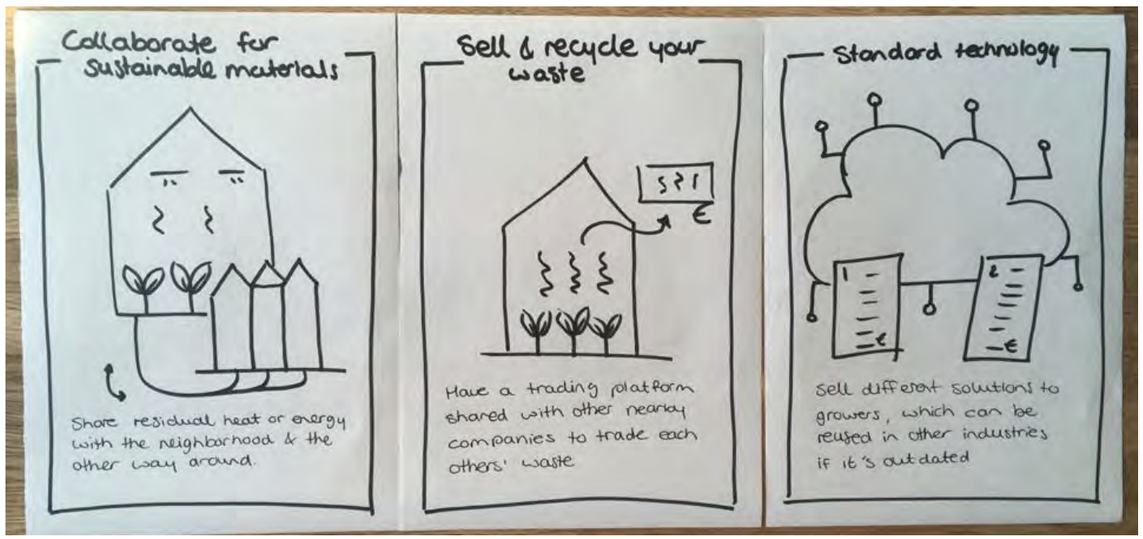


Figure 32: Idea cards of concept 2 (own illustration)

6.4 Concept evaluation

6.4.1 Goal

The goal of this phase is to choose one concept, which will be further elaborated on in the next phase of the process.

6.4.2 Method

To evaluate the concepts, different discussion sessions were organized with different KPN employees. The first session was planned with Titia and Daan, both business consultants Internet of Things at KPN. In this session, a presentation is given to give them background information, based on previous research (see appendix F). Afterward, three concepts were discussed, where the most important topics were technological possibility, chances for KPN, and possible partnerships. The second session was planned with Jan Rijk, innovation strategist and agricultural expert at KPN. In this session, the same presentation (see appendix F) is given and the three concepts were discussed. The most important topics of this discussion were possible partnerships and a more in-depth discussion about the needed technologies. At last, there was a session planned with Ellen, innovation lead at KPN. In this session, the same presentation (see appendix F) is given and there was an open discussion about the three concepts. Within this discussion, the focus was on the topics of business potential and pitfalls for KPN, and possible partners and partner requirements. Afterward, all feedback is taken into account, the list of requirements is supplemented. To make a final choice, the three concepts were tested based on the list of requirements.

6.4.3 Results

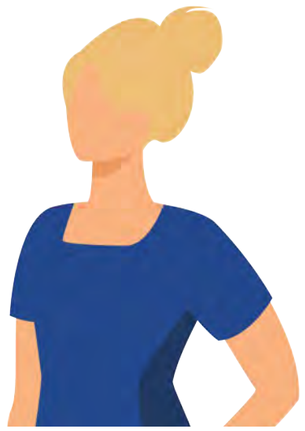
During the conversation with Titia and Daan, it was highlighted that they see the most potential in concepts 1 and 2 for this graduation project. This choice is based on the new business potential for KPN and that these concepts were more sector-specific solutions. Where concept 3 was an eye-opener for them because they didn't know growers were open to collaborating for energy with the area. For this concept, they want to come into contact with a grower, to evaluate the possibilities. Discussing the technological possibilities of concepts 1 and 2, there wasn't a big technological obstacle. The biggest obstacle they saw was the missing knowledge of the crop process KPN has. However, therefore partners need to be chosen strategically, to create an ecosystem that includes technology suppliers who are already in the field of horticulture. To conclude, Titia and Daan see the most potential in concepts 1 and 2, where they see some overlap in the two concepts which has both potentials.

Titia & Daan
Business developers IoT KPN

During the conversation with Jan Rijk, mostly concepts 1 and 2 came to the attention. This because Jan Rijk's expertise isn't in the energy. He saw business potential in both concepts 1 and 2. Where in both cases the first step was to make the solution smart, then make a digital twin, and afterward make it autonomous. Where concept 2 is mostly focused on plague and pestilence, concept 1 is more focused on the automation of multiple resources to optimize the crop process. Technologically there is a need for AI, robotics, 5G, and horticultural monitor technology. To create a big business potential for KPN, partnerships are needed to grow together. Where it's important to prevent that KPN's 5G in the ecosystem from becomes a commodity that is easily replaceable by other network providers. Besides that, there was also a discussion about the time pacing of the horizons. For the first step to making the solution smart, this could take longer than 5 years when the government isn't supporting this with subsidies and there need to be started from zero. While the last two steps, don't take 5 years when there already is an AI-trained algorithm. To conclude, Jan Rijk sees the most potential in concept 1 and 2, where he sees some overlap in the two concepts which has both potentials.

Jan Rijk
Innovation strategist and agricultural expert KPN

During the conversation with Ellen, it also became clear that she saw the most potential in concepts 1 and 2 because for concept 3 she didn't saw a business potential for KPN. Ellen identified the most business potential in concept 2 because KPN is in this solution the most logical partner and it's in line with one of the focus themes within IoT: 'connected drones'. However, she also saw the business potential in concept 1, because the market is steering in this direction, so she says that this eventually will happen. Besides that, there was a discussion about pitfalls for KPN within an ecosystem. A pitfall for KPN within an ecosystem is to take the force majeure and do too much themselves. Whereas the most potential in an ecosystem is to be all equivalent to each other and



Ellen
Innovation lead KPN

grow together. Currently, KPN has many ecosystems with start-ups, SMEs, and market leaders. Where in ecosystems with start-ups KPN is mostly pulling the start-up into the market and doesn't get a lot of value in return. Therefore in the next partnerships, KPN wants to enter, it's preferred to do this with SMEs and/or market leaders, who can provide KPN the value of scalability, reciprocity, development speed, development operations, and/or safety. To conclude, while Ellen had the preference for concept 2, she could see the bigger risk to dive into this solution because this also includes more start-ups within a possible ecosystem. What gave her the opinion to also see big business potential in concept 1, which is a smaller risk.

To make the final choice the weighted objectives method is used including the list of requirements, while the feedback of KPN employees was taken into account (see figure 33). Which gave the outcome to choose concept 1, monitoring service. This concept will be further elaborated in chapter 7.

	Weight	Monitor Service		Drones can do everything		Save energy together	
Optimize the crop process by increasing the productivity of the greenhouse.	25	5	125	4	100	2	50
Decreases the amount of needed resources to grow crops.	20	5	100	5	100	2	40
Be affordable for a grower to purchase	15	4	60	4	60	5	75
Must be beneficial for most of the stakeholders	15	4	60	4	60	5	75
Be created by stakeholders which should be able to add value to other stakeholders.	25	5	125	4	100	5	125
			470		420		365

Figure 33: Weighted objectives method to chose the final concept (own illustration)

6.5 Main take-aways

Idea generation To generate as many ideas as possible to increase the sustainability potential of the horticulture a creative session is organized. During the creative session, 114 ideas were generated using the circularity card deck of Konietzko, Bocken & Hultink (2020). All ideas were generated from the perspective of growers, where technological possibilities weren't included.

Idea visualisation All ideas from the creative session were clustered into 25 ideas cards. All ideas were visualized in the same format to make it easy to compare all ideas with each other and get a quick overview of the ideas.

Conceptualization Three concepts are developed based on the 25 idea cards: Monitoring Service, Drones can do everything, and Save energy together.

Concept evaluation All three concepts were evaluated with four different KPN employees. Based on these evaluation concepts and the weighted objectives method, the Monitoring Service is chosen to have the most impact on the sustainability potential of the horticultural sector and be most feasible for KPN.

To be determined next Now there is a concept developed and chosen, the next chapter needs to identify the realization and implementation of this solution within the horticultural sector.

07 Implementation of Monitoring Service

This chapter elaborates on the monitoring service concept which is explained in paragraph 6.3.3. A strategy is developed which eleborates on the commercialization of the concept, the creationg of an ecosystem around the solution and identifies the role of KPN within the solution and ecosystem. This strategy is visualized in a roadmap, which visualized a possible road towards the solution. The roadmap is divided into three horizons, where this chapter gives a rationale to.

Content

7.1 An introduction to Monitoring Service

The main goal of the design is to create optimal circumstances for crops to grow with minimum amount of needed resources which eventually will be regulated autonomously. This solution will increase the productivity of the greenhouse, by establishing a high-quality greenhouse to grow a high-quality plant. It will also ensure the need to only use the number of resources a crop needs to grow, which is the most sustainable way of growing.

7.1.1 What is the Monitoring Service?

Monitoring Service is a service which automatically fulfills the need of the crops. The working of Monitoring Service is visualized in figure 34. Data is gathered by sensors. This data is in the beginning only used to train the algorithm to know the optimal growing process of the crops. When this algorithm is trained a digital twin can be made which is a digital copy of the greenhouse. Digital twin is constantly updated by real-time data from the sensors. The digital twin can be compared with the optimal growing process of the AI algorithm, to know what every plant needs to optimally grow.

7.1.2 How does the Monitoring Service help the growers?

Currently, the climate is controlled at the greenhouse level, where there isn't feedback for each individual plant. Growers mainly decide the needed amount of resources based on data on the scale of the whole greenhouse. In this situation, it's not known what the impact is of giving the crop for example more water because is visible after 8 weeks. Using Monitoring Service increases the efficiency of growing as well as increases the sustainability potential as this is visible after only using the needed resources. Another benefit for the grower is that the AI algorithm will constantly keep optimizing itself, and therefore not become outdated. When more knowledge is known, perfect circumstances and amount of resources can be generated based on AI algorithms. Data that can be gathered is the amount of needed water, energy, heat, or the detection of an early age virus to prevent spreading.

7.1.3 Growing as a service

Most of the technology which is launched within the horticultural sector are offered as products that need to be bought. Based on the interview results of paragraph 4.3, new technologies are big investments, where the costs are the biggest barriers to buy new technology. Within the design of Monitoring Service, this barrier is decreased to offer the solution as a service. In this way, there is not one big investment a grower needs to do, and there is an opportunity to keep the platform up to date by software or hardware updates. This makes the solution durable and increases the relevant lifetime of the solution.

7.1.4 The challenge of the Monitoring Service

To launch Monitoring Service, collecting data to train the AI algorithm is the biggest challenge. When there isn't enough data collected, the solution can't be launched. Therefore it's key to find a grower who is open to data gathering of his crops. Besides finding the grower, it's also important to discuss the sensitivity of training AI algorithm based on his crops, and afterward wanting to scale the solution to other growers. Nowadays, growers are open to sharing their solutions based on their greenhouse data, which is not specified on crops specifically. Every grower is growing his crop differently to create other quality. Sharing information can result in a situation where other growers will take advantage of your knowledge. Therefore it's important to be aware of this sensitivity while developing the solution.

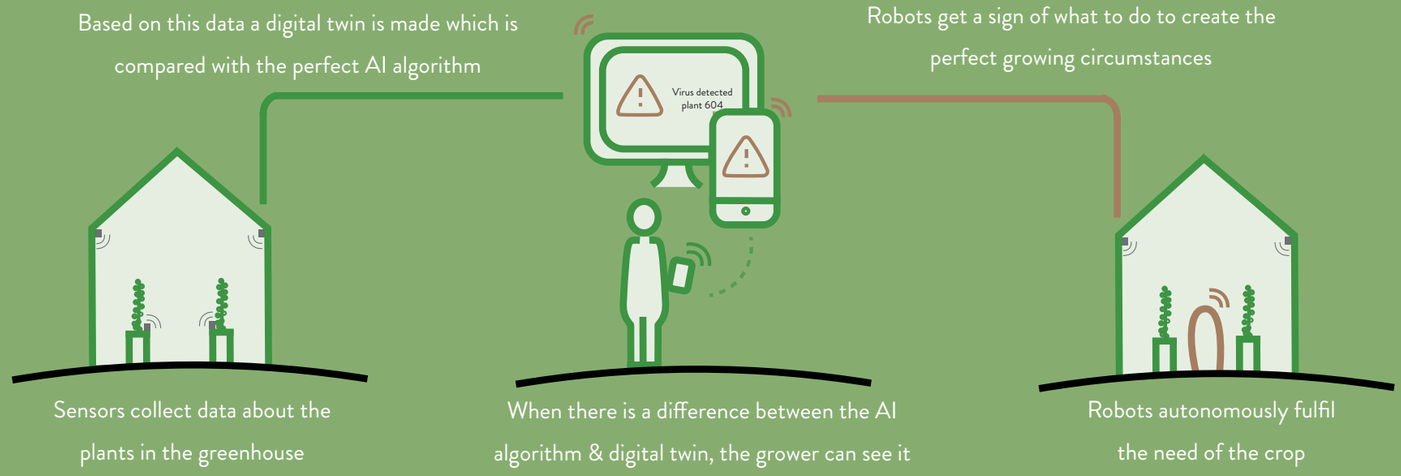


Figure 34: Schematic visualisation of the Monitoring Service process.

7.2 An overview of the implementation

To come to the end stage where Monitoring Service is fully implemented and growing is regulated remotely, there are still some steps to take. Therefore the implementation of Monitoring Service is divided into a timeframe with three horizons. Figure 35 gives an overview of the three horizons: Become a smart grower, Become a remote grower and Become an autonomous grower.

7.1.1 Horizon 1: Become a smart grower

Horizon 1 starts in 2022 and focuses on data collection of the crops' growing process and the training process of artificial intelligence (AI). The benefit for the grower is the improved, more detailed version of feedback from his greenhouse and crops. Now only data is collected on the scale of the whole greenhouse/table where the plants are on, where there is a need for more detailed information on crop scale. The grower is getting reached by the trusted technology supplier of their climate control technology. Climate control technology guarantees nowadays an optimal greenhouse climate using sensors. Monitoring the optimal crop process is a logical extension to create not only an optimal greenhouse climate but also optimal growing conditions per crop. When there is enough data collected and the AI is trained to know the optimal growing process, the second horizon is ready to start.

7.1.2 Horizon 2: Become a remote grower

Horizon 2 starts in 2024 and focuses on creating real-time feedback for the grower. Where data of his crops are collected and converted into a digital twin of his greenhouse. AI continuously compares the digital twin with the perfect version of the greenhouse. This results in real-time feedback for the grower of what every plant needs to optimally grow. Based on this feedback, other technologies can react to the need of the crops. The biggest benefit for the grower is to know what every plant needs at every moment to grow optimally. When the platform can easily compare the digital twin of the greenhouse and convert it into concrete steps for the grower and his technology, the third horizon is ready to start.

Horizon 3: Become an autonomous grower

Horizon 3 starts in 2026 and will focus on making the greenhouses autonomous. Based on the data and experience of the last two horizons robotics are included to regulate all resources and circumstances of the greenhouse and its crops. One platform connects all technologies in the greenhouse and connectivity will make them collaborate. Sensors and visual recognition are used to gather data to make the digital twin of the greenhouse and compare it with the data of the AI algorithm. When the digital twin isn't the same as the algorithm, robotics get signals to fulfill the need of the plant. In this way, the grower doesn't need to invest time and labor in growing his crops while his crops are regulated in perfect circumstances. When a grower wants to get more insights into data and robotics, the platform can easily be opened on the computer, laptop, or mobile phone. This gives the grower the power to be connected to his greenhouse anywhere at any time.

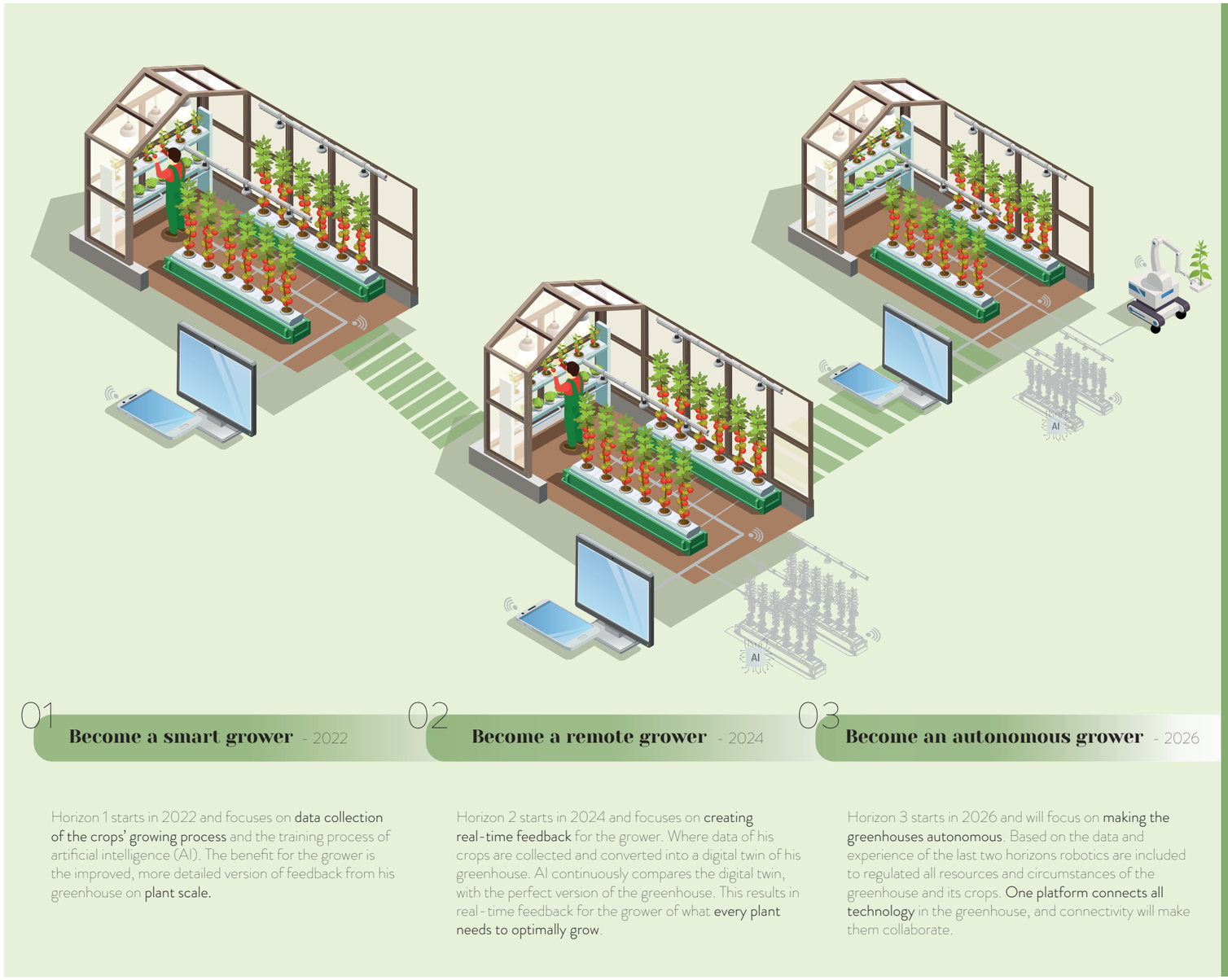


Figure 35: An overview of the three horizons (own illustration)

7.3 Time pacing

Timing for the three horizons is based on the technological possibilities based on a conversation with Jan Rijk, innovation strategist, Niels, director of Technology Roadmaps, and Jacob, EVP Innovation & Partnerships. The visualization of the time pacing is illustrated in figure 36. The year 2022 is almost upon us and it's decided to start an ecosystem for continual innovations which includes different technology suppliers, horticultural suppliers, and at least one grower, to be able to collect data to train the AI algorithm.

As said in paragraph 7.1.4, gathering data is the biggest challenge to successfully launch Monitoring Service. Therefore it's important to first collaborate with a grower who is open to gather data about his crops. When a grower is open for collaboration, training the AI algorithm can take some years. These years can be accelerated by a strategic partnership with stakeholders who are already developing AI for greenhouses, for example, Wageningen University and Research.

When data is collected the second horizon will start which uses a trained AI algorithm to give the grower real-time insights which resources to add to create the perfect product. The collected data continuously compares the circumstances with the ideal situation, to be able to indicate what every plant needs to be able to grow optimally. When this indication works perfectly, the next phase can start.

Horizon 3 focuses on automation, where robotics are integrated into the greenhouse that autonomously controls the crops. One platform brings all data and technology together, to create a clear overview for the grower. This platform also connects all technologies, so the growing process can be done autonomously. So only the resources needed are used.

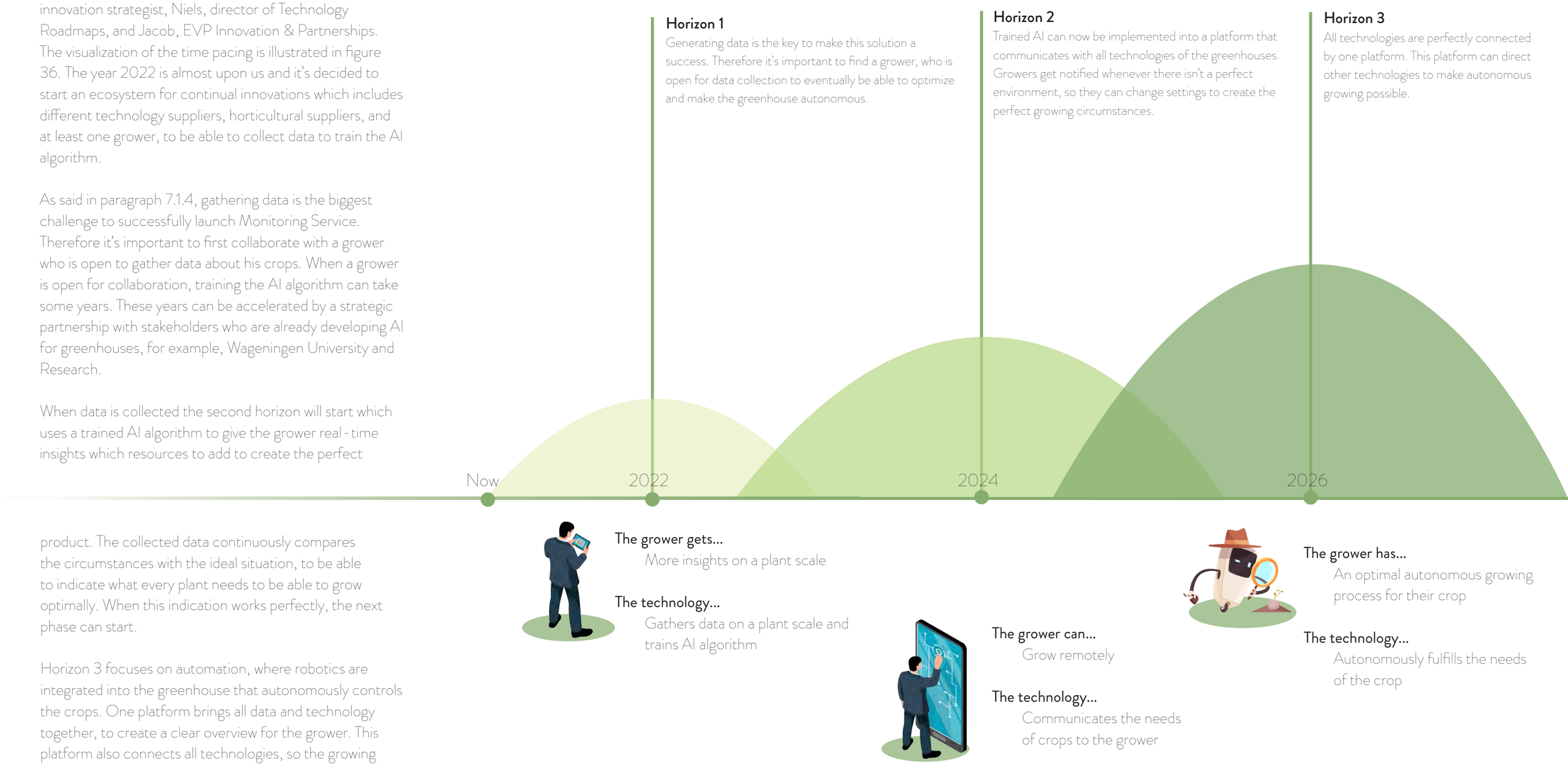


Figure 36: Time pacing (own illustration)

7.4 Become a smart grower

Horizon 1

The goal of the first horizon is to gather enough data to learn AI how to guide the optimal growing process of crops. Therefore it's important to target the right grower, who is open to collaborate and share his data and also collaborate with partners to be able to set up an ecosystem for continual innovation. The benefit for the grower is to generate insights on a plant scale (see figure 37), with the perspective to be able to generate the perfect growing process and be able to grow autonomously.

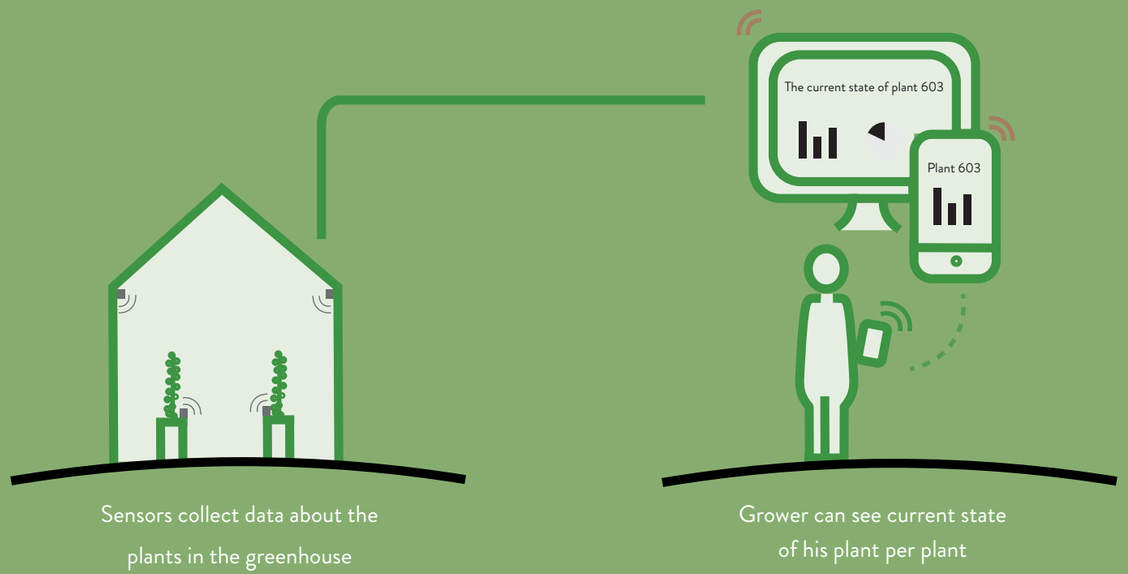


Figure 37: Schematic visualisation of the Monitoring Service process - horizon 1

7.4.1 Prospects

The target customers for the first horizons are growers who are precursors of innovation in the Dutch horticultural sector. Aspects that characterize these growers are growers which have a separate person or department responsible for innovation and technologies. These growers are continuously in contact with their current suppliers and other growers to find new technologies or innovate their greenhouse. Concluded from interview results of paragraph 4.3, growers preferably work together with their current trustful suppliers. Therefore the solution must be in collaboration with a current supplier of the horticultural sector.

One of the biggest barriers to adopt new technology is affordability. Decreasing the barrier by minimizing the costs for the grower is a major requirement to succeed. Therefore it's important to collaborate with investors. Another possibility to decrease the costs for the grower is to fund the proof of concept by KPN. This will decrease growers' costs, which is a benefit for the first grower who participates in the first version of the Monitoring Service. KPN can finance the implementation of the Monitoring Service, while the grower only needs to pay for the service when it's working optimally.

Within horticulture, there are many different crops grown, where tomatoes and pot plants are most dominant and less specialized are for example all different kind of cut flowers. Therefore it's most easy to start targeting growers who grow tomatoes and pot plants. In this way, it is easy to gather as data much more quickly to develop the AI algorithm. In the current research development, Wageningen University of Research (WUR) is already developing AI algorithms for tomatoes. Therefore tomatoes are the best crop to start with, to be able to realize the solution within the time frame of paragraph 7.3. When the development of the AI for tomatoes started, pot plant growers can be targeted.

Another advantage of collaborating with a big grower is that it could be possible to train the AI algorithm under different circumstances. If growers are open to collaborate in their greenhouse, certain tomatoes can vary in different amounts of water usage of light, which could fasten the AI to quickly develop the ideal circumstances.

7.4.2 Product

Products which will be components of the Monitoring Service for the growers are sensors, which gather data, and a platform where this data is translated into useful information about all crop individually. Data about water, temperature, light, and CO_2 need is gathered to determine the optimal resources need. Besides that, a data safe is also sold to store the data safely. Growers who are part of the ecosystem of the Monitoring Service are owners of their data and pay for the service of using the AI algorithm. When growers step out of the ecosystem, the AI algorithm isn't theirs but their generated data can be carried with them.

7.4.3 Partnerships

To be able to develop this solution, an ecosystem is needed to realize the Monitoring Service. The most important partner is a current horticultural technology supplier. This partnership has the benefits to easily enter the horticultural market, create more market knowledge, and makes it easy to contact the first prospects. The chosen horticultural technology supplier is Ridder, a market leader in the Dutch horticultural sector who provides climate control in greenhouses. Ridder already has a big range of customers, such as innovative tomato and pot plant growers, who can be the first prospects of Monitoring Service.

Other important partners are Glastuinbouw Nederland, the Government, Rabobank, and Nationaal Groen Fonds. These partners can invest and lobby for this solution, to make the Monitoring Service a success. As investors, there has been chosen for Rabobank and Nationaal Groen Fonds, because these parties are mostly involved in projects which support sustainable agriculture. Glastuinbouw Nederland and the Government is involved as a partner to create more support for the solution in the horticultural sector.

To train the AI algorithm it's important to include a trustful partner who is an expert in developing AI algorithms. Therefore OptNet is chosen as a partner for the Monitoring Service. OptNet is already a partner of KPN, which makes it easier to include in the ecosystem in the advantage of KPN. When KPN enters the ecosystem, KPN could introduce OptNet as an AI expert. This is a competitive advantage in comparison with other connectivity competitors, which can only provide connectivity into the ecosystem.

The last important partner for the Monitoring Service is the Wageningen University of Research, which is already developing certain AI algorithms to optimize the crop process. KPN already collaborates with the Wageningen University of Research for other solutions, which simplifies including the Wageningen University of Research in this solution.

7.4.4 Promotion

Ridder is the most important partner to reach the grower in the first horizon. Most promotion will be via mouth-to-mouth promotion during conversations with Ridder and their customers. Another way to reach the target group will be via online columns on horticultural platforms, see example column in figure 38. This is also a place to get contacted by interested growers. Growers can leave their e-mail addresses in the columns when they are interested. This makes it easy for the ecosystem to reach the first customers.

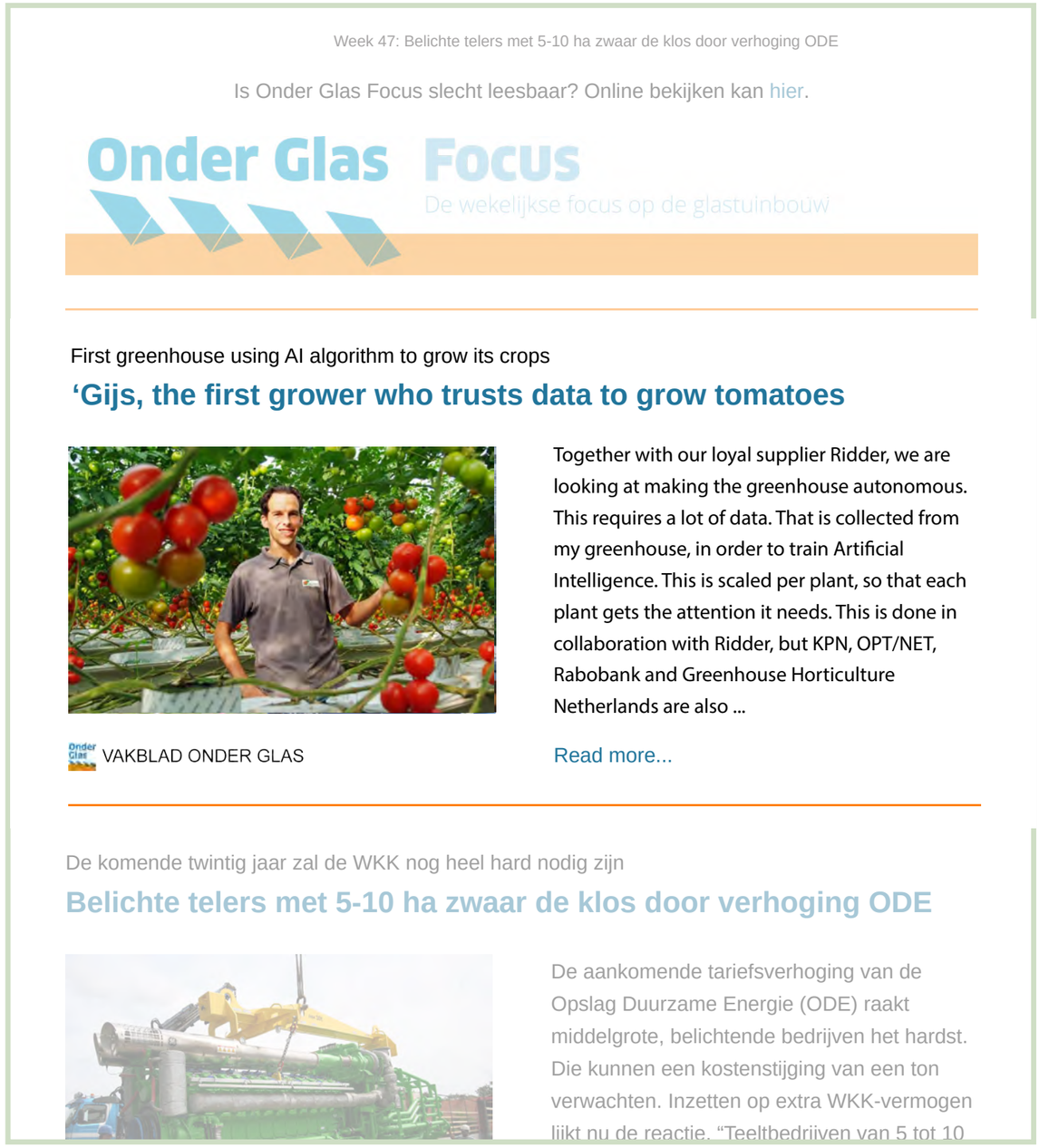
The first grower will be the center point of the promotion. This creates more conviction by other growers because the technology is already in use by one grower instead of only tested within a test greenhouse.

Another important requirement of the promotion is promoting the Monitoring Service as one ecosystem. This means that one party of the ecosystem is the contact person for growers, which preferably needs to be Ridder. Ridder is already involved in the sector and has the biggest trust and closest connection with the target group.

7.4.5 Positioning of KPN

Within the ecosystem, KPN provides the connectivity to connect all technologies with the platform. Besides the connectivity, KPN also sells its service as data safe. This data safe is a service that guaranteed the safety of the data, which keeps collected within the ecosystem. This gives growers the ownership of their data, where it's also visible for other stakeholders in the ecosystem for further development of the solution. For KPN this service is also known as Data Services Hub, which is sold as a platform-as-a-service that translates data into information and shares data with the approved stakeholders.

Within the development and promotion of the solution, KPN doesn't need to take the lead in the ecosystem or overpower the solution. When KPN takes a smaller position within the ecosystem and focuses on its expertise in connectivity and data security, the solution has more chance to succeed. Thereby it's important to radiate KPN's brand image of trust and security while keeping their promises and commitment to the ecosystem.


Week 47: Belichte telers met 5-10 ha zwaar de klos door verhoging ODE

Is Onder Glas Focus slecht leesbaar? Online bekijken kan hier.

Onder Glas Focus

De wekelijkse focus op de glastuinbouw

First greenhouse using AI algorithm to grow its crops

'Gijs, the first grower who trusts data to grow tomatoes

Together with our loyal supplier Ridder, we are looking at making the greenhouse autonomous. This requires a lot of data. That is collected from my greenhouse, in order to train Artificial Intelligence. This is scaled per plant, so that each plant gets the attention it needs. This is done in collaboration with Ridder, but KPN, OPT/NET, Rabobank and Greenhouse Horticulture Netherlands are also ...

VAKBLAD ONDER GLAS

Read more...

De komende twintig jaar zal de WKK nog heel hard nodig zijn

Belichte telers met 5-10 ha zwaar de klos door verhoging ODE

De aankomende tariefsverhoging van de Opslag Duurzame Energie (ODE) raakt middelgrote, belichtende bedrijven het hardst. Die kunnen een kostenstijging van een ton verwachten. Inzetten op extra WKK-vermogen lijkt nu de reactie. "Teeltbedrijven van 5 tot 10

Figure 38: Example online column (Adapted from Onder Glas, 2021)

7.5 Become a remote grower

Horizon 2

The goal of the second horizon is to continuously compare the perfect crop's circumstances with the current circumstances to generate concrete steps for the grower; what the grower needs to adjust for an optimal growing process. For this horizon, all stakeholders must work together, while the Monitoring Service for the grower is controllable via one platform. The benefit for the grower is the possibility to grow remotely and know the perfect growing process (see figure 39). In this way, only the needed resources are used to grow the crops, which increases the sustainability potential of the horticultural sector.

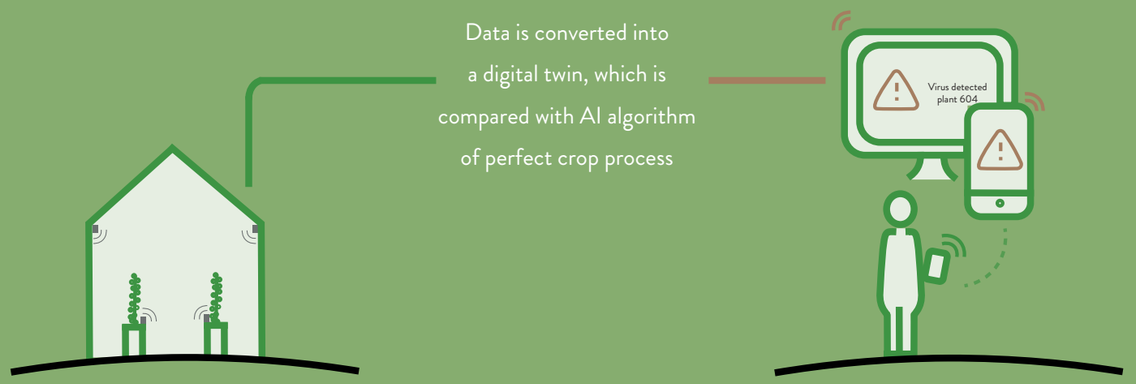


Figure 39: Schematic visualisation of the Monitoring Service process - horizon 2

7.5.1 Prospects

The target customers for the second horizon are growers who are preferably friendly competitors of the growers of horizon 1. In the horticultural sector, growers already work together with other growers to optimize their greenhouses.Nowadays, growers only exchange insights based on their whole greenhouse and keep insights about their exact crop process secured within their company. Growers don't want to share this information because this can result in a situation where other growers will take advantage of their knowledge. Therefore it's important to eliminate this situation and secure all growers to treat their data secure.

However, to prevent making an AI algorithm for every grower, the Monitoring Service makes an AI algorithm per crop. This ensures growers not to exchange their valuable sensitive data about their crop process. Which is being stored in a data safe.

Growers who are part of the ecosystem all need to trust each other and have the intention to grow together. A simple start is to target growers in the second horizon who are already trusted by the targeted growers of the first horizon. Therefore the data safe can be demonstrated and increase the trust of all growers in the ecosystem.

To be part of the ecosystem and make use of the Monitoring Service, there needs to be certain agreements made between all growers. This makes sure all growers want to increase their sustainability and business potential together and don't only take advantage of the input from others.

7.5.2 Product

Products that will be components of the Monitoring Service for growers are sensors, which gather data, a data safe which secures the collected data, and a platform where data is translated into a digital twin of the greenhouse that is continuously compared with the AI algorithm. A digital twin is a virtual copy of the greenhouse that is continuously updated by data of the sensors to get real-time insights into the greenhouse. Based on the comparison of the digital twin and the AI algorithm the platform manages the needs of the crop. Using this, the grower can adopt the input to create an optimal growing process for his crop with the least amount of needed resources.

7.5.3 Partnerships

The ecosystem which is created in the first horizon is still active in the second horizon. The only new stakeholders within the ecosystem are new prospects. This is because of all stakeholders of horizon 1 are capable of creating the Monitoring Service of horizon 2.

7.5.4 Promotion

To reach prospects of the second horizon, multiple channels are important: mouth-to-mouth promotion, supplier advertisement, online columns, and media messages. To spread the publicity of the Monitoring Service, it's important to keep the updates spread within the horticultural sector. Concluded from the interviews in paragraph 4.3, growers talk regularly with each other on events, during casual meetings, or even on birthday events with the family. This mouth-to-mouth promotion can be very effective. When one grower already uses

the Monitoring Service and has a positive experience, other growers are more likely to try the Monitoring Service.

Besides mouth - to - mouth promotion, the promotion via Ridder keeps being important. When Ridder has several conversations with their customers, they should promote the Monitoring Service to their customers.

Online columns are already used in horizon 1 to promote the monitoring service. Nevertheless, almost all growers read online columns about the development of their sector. Therefore it's important to keep writing and posting online columns, to get the attention of growers.

The last channel to promote the Monitoring Service in horizon 2 is media messages (see figure 40). When there is a breakthrough in agriculture, a lot of news channels also want to promote innovations. The Netherlands is known of its innovative agriculture, so when the Monitoring Service is a success, it needs to be presented to the Netherlands. Via media messages, the Monitoring Service will get the attention of growers who are already reading the online columns, but also growers who don't read the online columns very often. This will increase the amount of reached people, that could lead to increased publicity and interest in the Monitoring Service.

7.5.5 Positioning of KPN

Within the second horizon, KPN delivers the connectivity to connect all technologies and will be responsible for the data safe. The data safe is being even more important in the second horizon because multiple growers make use of the same algorithm. KPN will provide the data safe as a service, which guarantees to safely store the data. This is where every grower who is included in the ecosystem can see all data and make use of the AI algorithm. The AI algorithm is being constantly updated based on the data of all growers. When a grower decides to stop being part of the ecosystem, KPN is responsible that this grower isn't able to see or copy any (historical) data of other growers and that the grower can't use the AI algorithm anymore. In this way, only growers who are part of the ecosystem have the right to see data and use the AI algorithm.

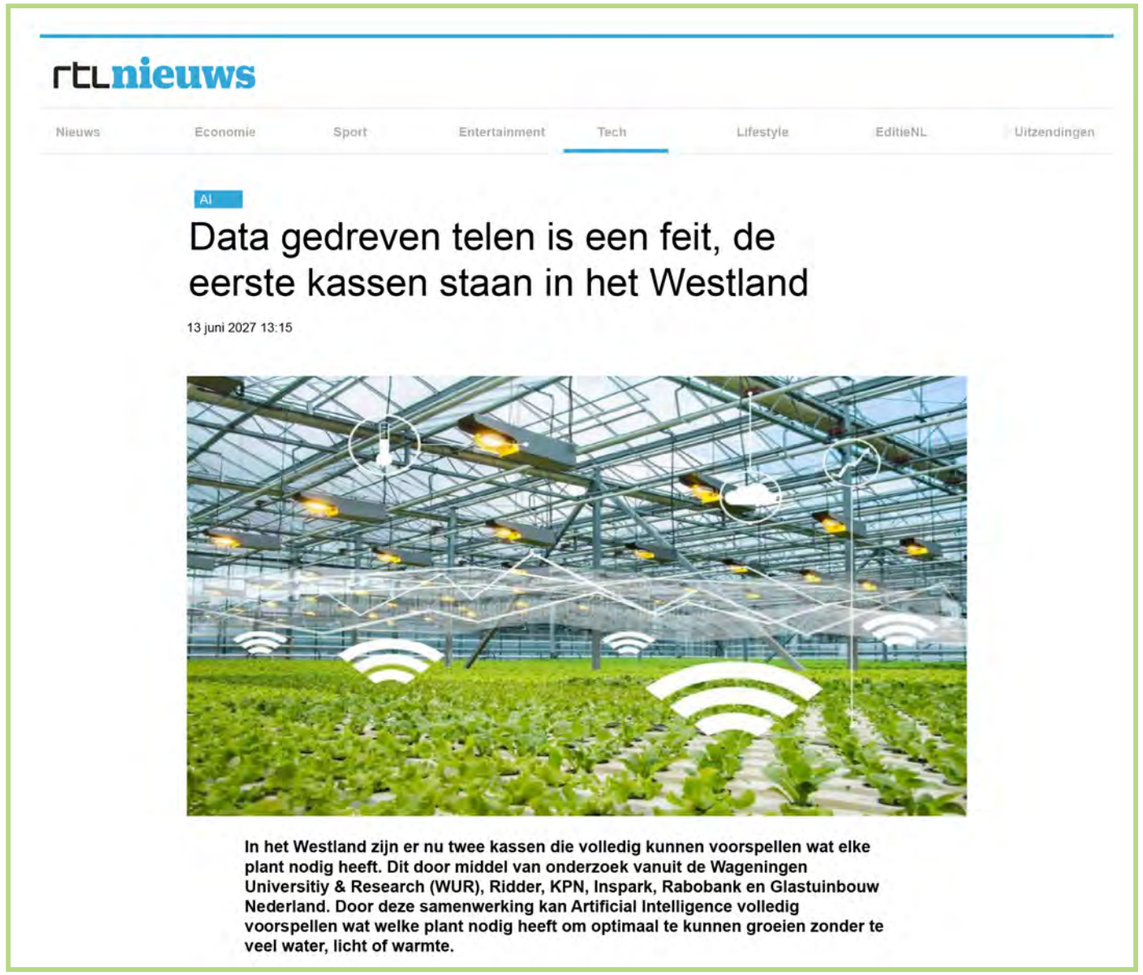


Figure 40: Example Media message (Adapted from Onder Glas, 2021)

7.6 Become an autonomous grower

Horizon 3

The goal of the third horizon is to realize autonomous growing while using only the amount of resources that are needed to stimulate the growth process of the crop optimally. Robotics are used to grow autonomously, which base their decisions on the digital twin and AI algorithm which are developed in horizon 2 (see figure 41). All technologies are connected via one platform, so growers have one overview of all technologies of their greenhouse. The benefit for the grower is the possibility to have an autonomous growing process of his crops, where only the needed resources are used to grow the crops. Which increases the sustainability potential and the efficiency of his greenhouse.

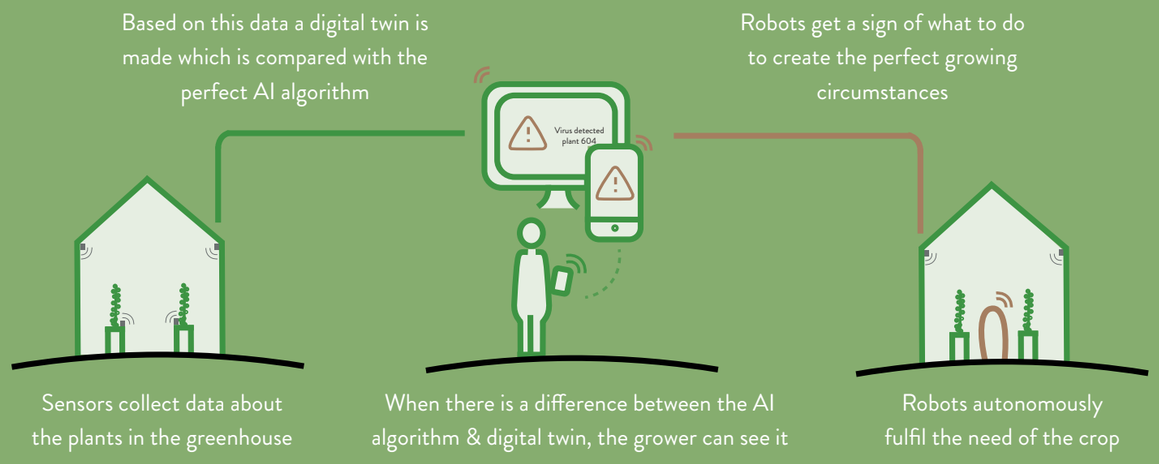


Figure 41: Schematic visualisation of the Monitoring Service process- horizon 3

7.6.1 Prospects

The target customers for the third horizon are all growers of Dutch horticulture. In the last years, the Monitoring Service is developed into a trustful solution. Therefore the acceptance of the service is increased, which provides more security for growers who are not as big or innovative as the growers of horizon 1 and 2.

The Monitoring Service is offered in different packages. There is a choice for the grower, if growers want to use robotics to grow autonomously or only want to use the sensors, AI, and digital twin to optimize the growing process. This lowers the barrier for growers to enter the ecosystem. New customers could only buy the Monitoring Service if they don't feel comfortable by also buying robotics which grows autonomously. But they can also buy them all in a package if they want to automize their greenhouse immediately.

7.6.2 Product

Products that will be components of the Monitoring Service for growers are sensors, which gather data, a data safe which secures the collected data, a platform where data is translated into a digital twin of the greenhouse, that is continuously compared with the AI algorithm, and robotics which grow autonomously. The monitoring service can be sold as a whole, which includes monitoring and autonomous growing. But growers can also only buy the Monitoring Service, without autonomous growing.

Both packages include the data safe which is already explained in paragraph 7.5.5, where every grower who is included in the ecosystem can see all data and make use of the AI algorithm. The AI algorithm is being constantly updated based on the data of all growers. When a grower decides to stop being part of the ecosystem, KPN is responsible that this grower isn't able to see or copy any (historical) data of other growers and that the grower can't use the AI algorithm anymore.

7.6.3 Partnerships

The ecosystem which is created in the first horizon is still active in the second horizon. Nevertheless, new stakeholders are included to facilitate autonomous growth by robotics. Octinion is chosen to be a partner for robotic autonomous growing because Octinion is a R&D company that is specialized in robotics for the agricultural sector. Octinion is responsible for the robotics in the greenhouse, which bases its decisions on the AI algorithm and digital twin of the grower. The robotics of Octinion is also connected to the platform of the Monitoring Service, to give the grower convenience of keeping a clear overview in one application.

7.6.4 Promotion

To reach prospects of the third horizon, multiple channels are important: mouth - to - mouth promotion, supplier advertisement, online columns, media messages, and trade events. All channels which are used in horizon 1 and 2 are also used to reach the target customers of horizon 3. Trade events are added as a channel because trade events reach all growers of the sector. At trade events, the concept is also shown, so growers can see how the solution works to show them the big benefit of the Monitoring Service.

7.6.5 Positioning of KPN

Within the third horizon, KPN delivers the connectivity to connect all technologies including robotics, and also deliver their service of the data safe. KPN is responsible to connect all technologies with their network, to be able to let all technologies communicate with each other. And with the data safe, KPN ensures that only growers who are part of the ecosystem have the right to see data and use the AI algorithm and their data is saved securely.

7.7 Tactical roadmap

All horizons of paragraphs 7.4, 7.5, and 7.6 come together in a tactical roadmap, which is visualized in figure 42. The end goal of the solution is to keep horticultural growers frontrunners of sustainable growing by collaboration and IoT. A possible road towards this end goal is visualized in a tactical roadmap.

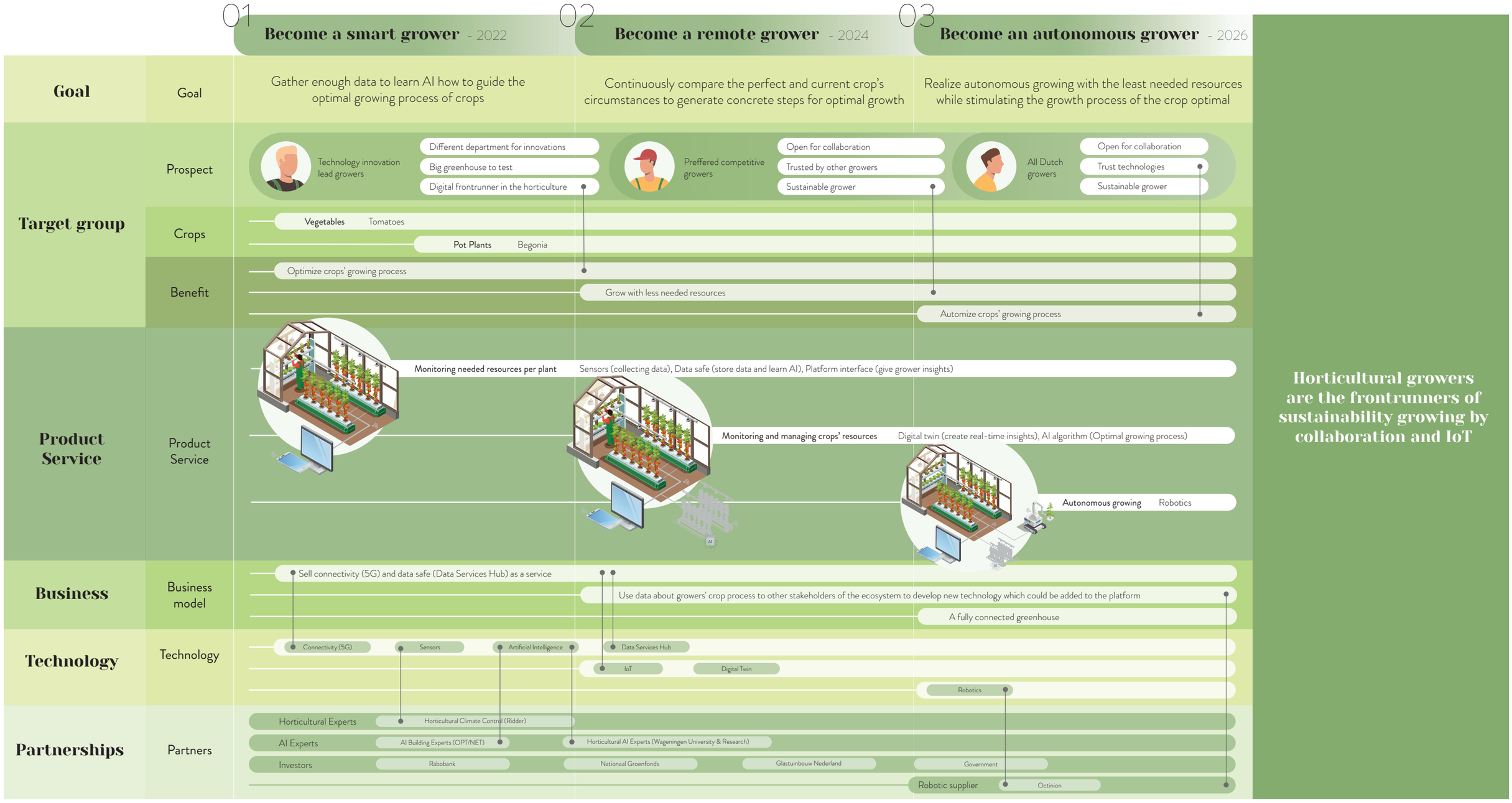


Figure 42: Tactical roadmap (own illustration)

08 Concluding the project

In this last chapter the conclusion of the project is given, where the research question is answered and advice for KPN is given. The discussion discusses the limitations and recommendations of this graduation project. Lastly, a personal reflection is written to evaluate the project from my point of view.

Content

8.1 Conclusion

8.1.1 Answering the research question

The project started with the problem statement: How to successfully launch sustainable IoT solutions in the horticultural sector? This changed in chapter 5 to: How to apply IoT to improve the sustainability potential in the horticultural sector? Based on the research of this project, IoT can be applied to increase the sustainable potential of the horticultural sector. IoT is mostly used to automate and increase the effectiveness of processes, where IoT can help the horticultural sector to decrease the number of needed resources and increase their productivity. Therefore it's key to know the optimal growing process of the crops, which is learned by complex AI algorithms.

Besides this problem statement, there was also another research question that needed to be answered: How to set up an ecosystem for continual innovations to increase the sustainability potentials of a sector? To set up an ecosystem for continual innovations, it's important to know the sector, the current problems, and the most important stakeholders. The ecosystem doesn't need to be created to only improve the sector, but also should understand the problem of the sector. When this problem is understood an ecosystem for continual innovations can be created, under the following conditions:

The ecosystem must exist of stakeholders, which...

- Are open to collabore instead of compete
- All exchange values with every other stakeholder.
- All have complementary skills.
- Are open to listen to end users' needs, to create a customer-facing solution.
- Are open to look towards the short-term and long-term perspective of the collaboration.

8.1.2 KPN's potential in the horticultural sector

The potential for KPN to be part of an ecosystem in the horticultural sector is available. However, to enter the market, KPN should create a better understanding of the market, the growers' problem, and the current stakeholders. Therefore it's key to start talking with current technology suppliers of the horticulture to get more in-depth knowledge of which technologies are needed to help growers.

Based on the research, there is a big chance for KPN to sell the Data Services Hub, the data safe as a service. This could be the starting point of trustful and safe collaboration between growers. This is needed to let growers collaborate in a trustful and secure way, which could make a change for innovations in the horticultural sector.

8.2 Discussion

8.2.1 Limitations

In chapter 7 the implentation of the Monitor Service is written. However, when KPN wants to take the next step to realize this there are some limitations that were not elaborated on during this project.

Relevance for KPN

The sector of agriculture is chosen based on personal preference and in collaboration with KPN. However, KPN also started to focus on other sectors, which resulted in the decision to not focus on agriculture as one of the main focuses. This made it sometimes hard to talk to people who didn't saw the value of KPN within agriculture.

COVID-19

Due to COVID-19, there was a lockdown which resulted in 100% working from home. All interviews were done online, which made it harder to dive into the topic. Especially the interviews with growers could have been more valuable when being offline. Luckily one of the growers invited me inside his greenhouse. However, it would have been even more effective if I could have seen multiple greenhouses with all different kinds of crops to experience the difference between crops.

Technology

KPN is a technology company, which is an expert in telecommunications, sensors, chips, networks, and all kinds of digitalization technologies. To produce the Monitoring Service, technologies need to be further elaborated. There needs to known what sort of sensors are needed, what kind of data we are talking about, and how to connect all devices. My educational background isn't focussed on these specific technologies, so therefore this project doesn't elaborate on these technologies in that sort of detail.

8.2.2 Recommendations

Based on the limitations of paragraph 8.2.1, recommendations are derived.

Relevance for KPN

Multiple people of KPN were really enthusiastic about the deliverables and insights of this project. Nevertheless, based on decisions of higher forces within KPN agriculture isn't the focus of KPN anymore. Therefore, KPN needs to decide if there is value for them in this industry based on this project. Different people have different opinions, so therefore there needs to be one conclusion for everyone, if this is a sector to focus on or not.

Technology

To get more specific knowledge on how to technologically develop the solution, there needs to be a conversation with the technology supplier Ridder. This conversation can be the start of a more in-depth technological detailed plan. Ridder is an expert in horticulture and knows which resources need to be measured and how, so KPN can conclude which sensors and what data is needed to realize the solution. Besides that, it can also be valuable for the solution to talk with every stakeholder of the ecosystem, and therefore also include the first grower during the development of the solution.

8.3 Personal reflection

During the last 5 months, I had quite a long journey, which resulted in my graduation project which gives me a proud feeling. At the beginning of the research, I was insecure and couldn't explain to others what I'm capable of. I found it hard to just start on a project which was still quite vague for me. The project brief gave a clear start, but besides that, all options were still open.

I liked to have many conversations with all different kind of people within KPN, that gave me new insights and all different kind of new perspectives. I found it hard to write things down in a linear story and combine my interview results, literature research, and desk research. However, during my project, I recognized that it's not a disaster to have this problem. So I made a miro board which helped me to create an overview and still let myself be creative. At the same time I got many compliments about the way of structuring my thoughts on my Miro board, which gave me more confidence. I even gave a Miro workshop to the department where I did my graduation project, to transfer my knowledge.

In the beginning, I thought the online working habit due to COVID-19 was an enormous obstruction to get to know the company, KPN, and the end customer, the growers. I would liked to be able to say that I went to KPN multiple times a week, but I only saw the office 2 days in 5 months. Nevertheless, because everyone was online, it made me more assertive. I started to just call people when I needed help, e-mail them or ask if I could visit them. I learned how much assertiveness can bring me, and I will continue developing this skill.

Besides this, I mentioned how hard I'm for myself if I'm stuck within my project for some days. As Erik Jan said: You were stuck, which is absolutely normal, only be stuck for 2 days is no problem at all. I will try to not be that hard to myself in the future and just accept the fact that being effective and productive 100% of the time isn't human.

At last, I want to say that I'm really enthusiastic about the network I build within KPN. I realized how much energy I got from working together with people. So presenting my project over and over again to all different kinds of people gave me energy. Their enthusiastic reactions made me even more enthusiastic, and their critical feedback helped me to develop an even better project. This made me not only enthusiastic about my project but also about working life in general. I thought my graduation project is just a project, but to hear that KPN sees value in the project and wants to continue with my project makes me even more proud of myself.

To conclude to me: You can do more than you think. Translating analytical findings into practical solutions can't be done by everyone, but you can!

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Appendix A: interview guide

Main research question:
How to successfully launch sustainable IoT solutions in the agriculture sector which is an outcome of an innovation process of an ecosystem?

Reason for this interview:
Know which problems they are facing in their greenhouses
Get to know why they adopt technology to help them
Get to know the barriers which they see of adopting technology
Get to know their opinion about sustainability aspects of their greenhouses
Get to know how technology can help them be more sustainable

Introduction [in Dutch]:
Goedemorgen/middag/avond,
Met Dyantha Fisser, ik bel u naar aanleiding voor onze afspraak voor een interview over technologie en duurzaamheid binnen de glastuinbouw. Ten eerste wil ik u alvast bedanken voor uw mee werking aan mijn onderzoek. Ik zal nog even kort het doel van het interview uitleggen.

Ik ben een student strategisch product ontwerpen aan de TU Delft en voor mijn afstudeerproject ben ik (in samenwerking met KPN) een onderzoek aan het doen over de implementatie van technologie binnen de glastuinbouw, met daarbij ook nadruk op duurzaamheid. Door u, en nog meer telers, te interviewen probeer ik er achter komen wat het perspectief van de telers is tegenover technologie en duurzaamheid in de kas.

Tijdens het interview zal ik u vragen stellen, waarbij ik vooral benieuwd ben naar uw ervaring. Hierbij zijn er geen foute antwoorden en bent u de expert op gebied van telen en uw kennis van uw kas. Het is een open interview, waarbij ik natuurlijk ook open sta voor uw inbreng. Stel hierbij vooral vragen als er iets niet duidelijk is of chroom niet om wat verder van de vraag af te gaan, mocht u iets te binnen schieten wat ook interessant zou kunnen zijn. Mocht er tussendoor iets zijn waarop u geen antwoord wil geven, of waar u zich niet prettig bij voelt, geef dit dan vooral aan, dan slaan we dit onderwerp gewoon over en gaan we naar de volgende vraag.
Alle informatie zal ik vertrouwelijk behandelen. Hierbij zou ik wel graag de grootte van uw kas en het gewas wat u teelt willen verwerken als gegevens. Daarbuiten kunt u volledig anoniem blijven. Echter zou ik wel graag het interview willen opnemen, zodat ik achteraf nauwkeurig de informatie kan verwerken voor mijn onderzoek. Deze opname zal alleen ik bekijken/beluisteren en zal hierna worden vernietigd. Gaat u hier akkoord mee?

Het interview zelf zal maximaal 45 minuten duren. Heeft u op dit moment nog vragen?
Laten we dan maar aan de slag gaan, dan zet ik nu de opname aan!

Interview guide [in Dutch]:
Thema 1: Uw kas
Als eerste zal ik wat vragen stellen in telen over het algemeen. Hierbij ben ik benieuwd naar uw ervaring.
1. Als eerste zou ik graag meer willen weten over uw kas:
   - Hoe groot is uw kas?
   - Wat is het gewas wat u laat groeien?
   - Hoelang zit u al in het telers vak?
2. Wat zijn terugkomende problemen waar u tegen aan loopt tijdens het telen?
   - Denk hierbij aan de categorieën:
     - Werknemers
     - Energie
     - Duurzaamheid
     - Gewassen
     - Verkoop van gewassen
   - Welke gevolgen hebben deze problemen?
   - Wat doet u er nu aan om deze problemen op te lossen of te verminderen?
   - Welke hulpmiddelen helpen u nu om problemen op te lossen?

Thema 2: Technologie in de kas
Nu ik wat meer weet over uw gewassen en telers, zou ik ook meer willen weten over technologie binnen uw kas en uw ervaring hiermee.
1. Als u terug denkt aan de veranderingen van de afgelopen jaren in uw kas, welke technologie is nieuw in uw kas?
   - Waar helpt deze technologie u mee?
   - Hoe heeft u gehoord van deze technologie?
   - Wat heeft u overgehaald om deze technologie ook te kopen voor in uw kas?
2. Wat is de laatste technologie die in uw kas is gekomen?
   - Kunt u mij meenemen in het proces van het aanschaffen van deze technologie?
     - Hoe kwam u op het idee om deze technologie aan te schaffen?
       - Waarom heeft u deze technologie aangeschaft?
       - Waarom twijfelde u bij de aanschaf?
     - Wat overtuigde u om de technologie aan te schaffen?
     - Waar helpt deze technologie u mee?
     - Waarvoor gebruikt u deze technologie?
     - Kunt u voordelen opnoemen van deze technologie?
     - Kunt u nadelen opnoemen van deze technologie of dingen die u graag zou willen verbeteren?
3. Zijn er bepaalde technologieën waar u van af wist, maar heeft gekozen om deze niet te gebruiken in uw kas?
   - Welke zijn dit?
   - Waarom heeft u er voor gekozen om deze niet te gebruiken in uw kas?
4. Kunt u voorbeelden noemen van leveranciers, waarvan u graag technologie koopt?
   - Waarom koopt u graag technologie van hen?
   - Waardoor geven zij u vertrouwen van de technologie?
   - In welke mate denken zij mee met uw problemen?

5. Welke problemen zou u het liefst zo snel mogelijk opgelost willen hebben?
   - Ziet u dit voor zich met technologie?
6. Stelt u zich voor, de ideale wereld binnen de kas, hoe zou technologie u helpen?
   - Welke problemen zal technologie kunnen oplossen binnen de kas? En hoe?
   - Wat zou doorslaggevende redenen zijn waarom u deze technologieën zou willen toepassen in uw kas?
7. Ik heb een aantal voorbeelden van technologie binnen de kas. Hierover hoor ik graag of u dit ziet werken in uw kas of niet;
   - Een drone die automatische ongedierte te lijf gaan en ze in hun vlucht versnipperen als gewasbestrijding, zou u dit in uw kas willen?
     - Waarom wel? Waarom niet?
   - Een AR-bril, waarmee u of uw werknemers door kunnen zien hoe het met uw gewas gaat en wat zij nodig hebben. Zoals bijvoorbeeld gewasbescherming, meer of minder water, of dat deze klaar zijn om geoogst te worden.
     - Waarom wel? Waarom niet?
   - Robot die herkent of uw gewas klaar is voor de oogst en hierbij ook de oogst plukt wanneer nodig.
     - Waarom wel? Waarom niet?

Thema 3: Duurzaamheid

Zo net hebben wij het gehad over technologie binnen de kassen, echter ben ik ook geïnteresseerd in uw kijk op duurzaamheid. Duurzaamheid lijkt steeds belangrijker te worden op de wereld. Hierbij ben ik benieuwd naar uw mening hierover.

1. Hoe denkt u over duurzaamheid binnen de glastuinbouw?
   - Wat doet u nu binnen de kas om duurzamer te telen?
   - Wat maken deze acties precies duurzaam?
   - Wat zijn uw plannen om komende jaren nog verder te verduurzamen?
   - Waarom wilt u verduurzamen binnen de kas?
2. Tegen welke problemen loopt u aan bij het verduurzamen van uw kas?
   - Hoe lost u deze nu op?
   - Wat zou u kunnen helpen om deze problemen te verminderen of op te lossen?
   - Van welke organisaties of leveranciers verwacht u hulp of steun bij het verduurzamen?
   - Hoe zou u willen dat deze organisaties en leveranciers u zouden helpen?
3. Wat krijgt u nu terug voor het feit dat u verduurzaamd?
   - In hoeverre motiveert dit u om nog verder te verduurzamen?
   - Wat zou u graag terug willen krijgen voor het feit dat u verduurzaamd?
   - Hoe toont u nu aan dat u duurzaam/duurzamer teelt?

Thema 4: Technologie & duurzaamheid

Zo net hebben wij het gehad over uw kas, technologie en duurzaamheid. Nu ben ik benieuwd hoe dit samen zou kunnen komen.

1. Is er technologie die u nu helpt om duurzamer te telen?
   - Zo ja, hoe helpt deze technologie u om duurzamer te telen?
2. Als alles technologisch mogelijk zou zijn, hoe zou in de idealen wereld technologie u helpen met verduurzamen?
   - Wat zijn de eisen die u stelt aan deze technologie?
   - Wat zijn de redenen waarom u deze technologie wel of niet zou willen kopen?

Appendix B: Creative session materials

Teun

Owner of the family greenhouse

About

Age: 44
Region: Noordoost-polder
Years in the field: 32
Education: Higher vocational education in agricultural sector
Crops: Flowers
Status: Married
Children: Three

From an early age, Teun helped his father with the cultivation. After secondary school, he completed Horticulture & Agribusiness at InHolland University of Applied Sciences. After this, Teun took over the family business from his father. In his spare time, he spends a lot of time with his family but also enjoys a cold beer in the pub with his friends.

Daily tasks

- Monitoring the entire crops process.
- Purchase raw materials and plan the crop
- Managing production employees or team leaders.

Frustrations

- The high sustainable requirements from the supermarkets
- Lacking understanding of the government how to be sustainable as a grower

Wants

- Sustainable business for the next generations
- Real-time feedback from his plants
- Subsidy to make sustainable innovations more affortable

"By establishing a high-quality greenhouse, we can also grow a high-quality plant."

Gijs

Technology and innovation leader

About

Age: 31
Region: Maasdijk
Years in the field: 5
Education: Wageningen University & Research in Agro technology
Crops: Tomatoes
Status: Married
Children: One

Gijs grew up in 't Westland, surrounded by greenhouses. He decided to study in Wageningen, because of his interests in this beautiful sector. Now he is responsible for the technology and innovation within the greenhouse that he works. In his spare time, he is surrounded by family and friends, or enjoys sports activities, such as cycling and running.

Daily tasks

- Keep up to date with the latest technology developments
- Meeting with technology suppliers to discuss needs of the greenhouse
- Collect data from the crops progress to optimize the product system

Frustrations

- Increasing crop diseases
- High need for affordable and knowledgeable labor
- High energy prices

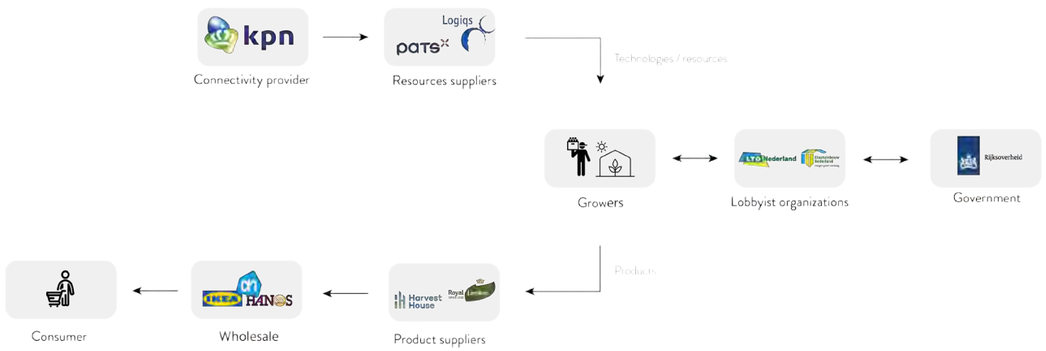
Wants

- Continual crops feedback, preferably plant-specific
- Sustainable options to continue in the horticultural sector

"The customer is demanding sustainability and we just have to comply. That is fine, but it will cost us a little bit more money."

To grow a flower/tomato needs....

Current supply chain



Design goal

What is the 'real' problem?

- High pressure to innovate
  If there is something new developed, it becomes easily the 'new standard'. And therefore, there is always an increasing pressure to keep innovating.
- What is sustainable?
  Sustainability always needs to be improved, but there is no standard which validates if it's 'good enough'. There is no end goal, or realistic yardstick.

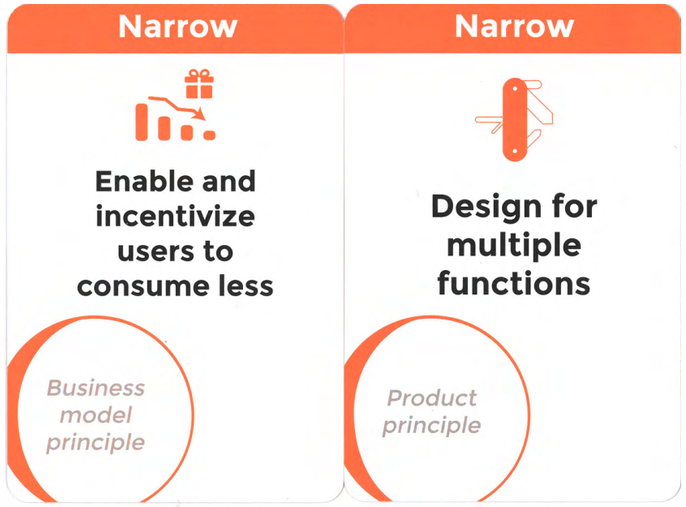
"Will this investment be worth it? Or will it be outdated in a few years?"

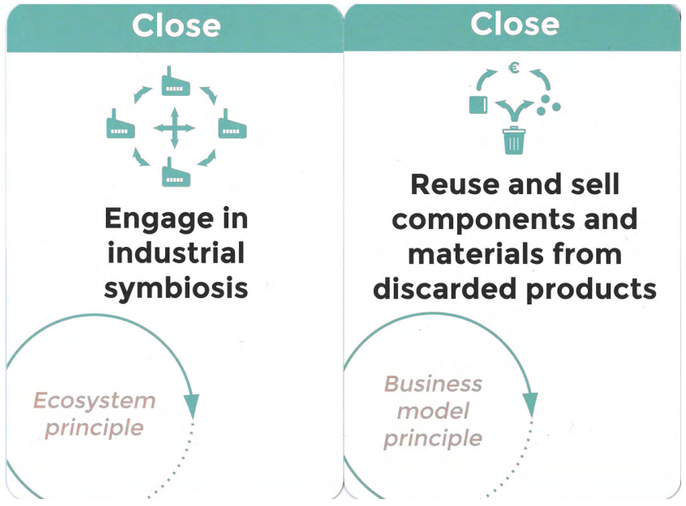
"For how long will this solution be sustainable enough?"

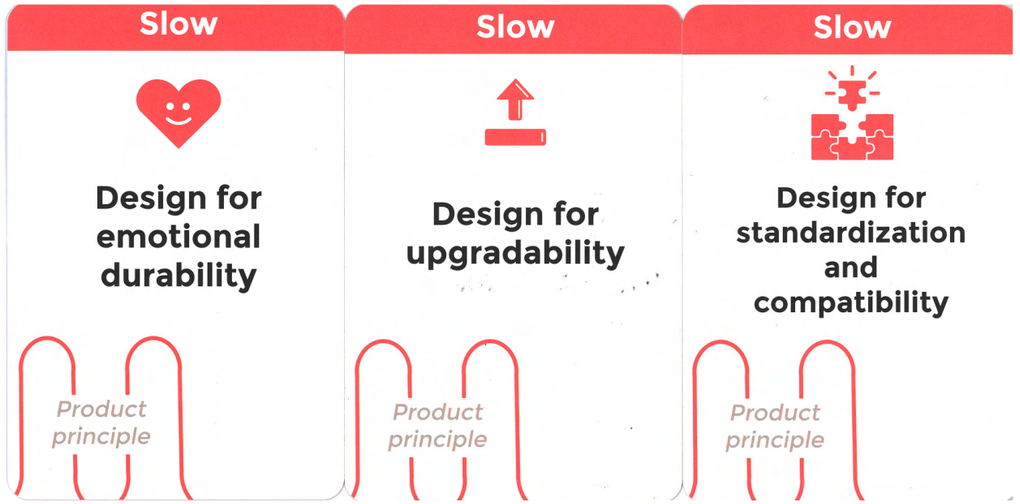
Design goal:

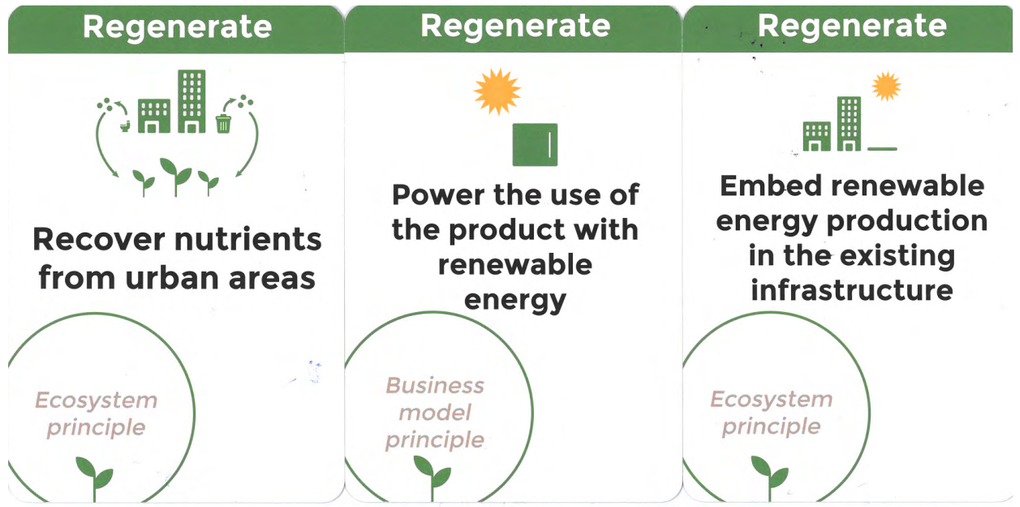
Design a strategy to innovate the horticultural sector in a durable way

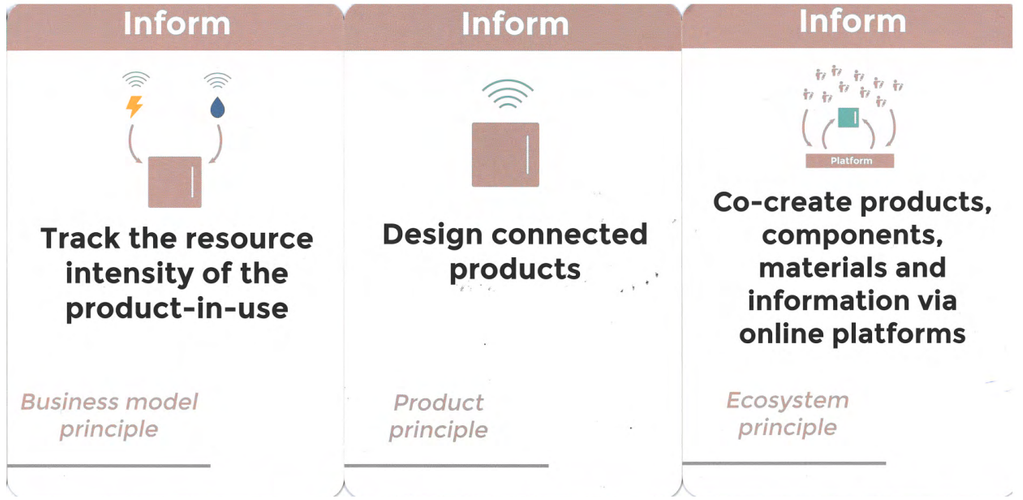
Appendix C: Chosen Circularity deck cards



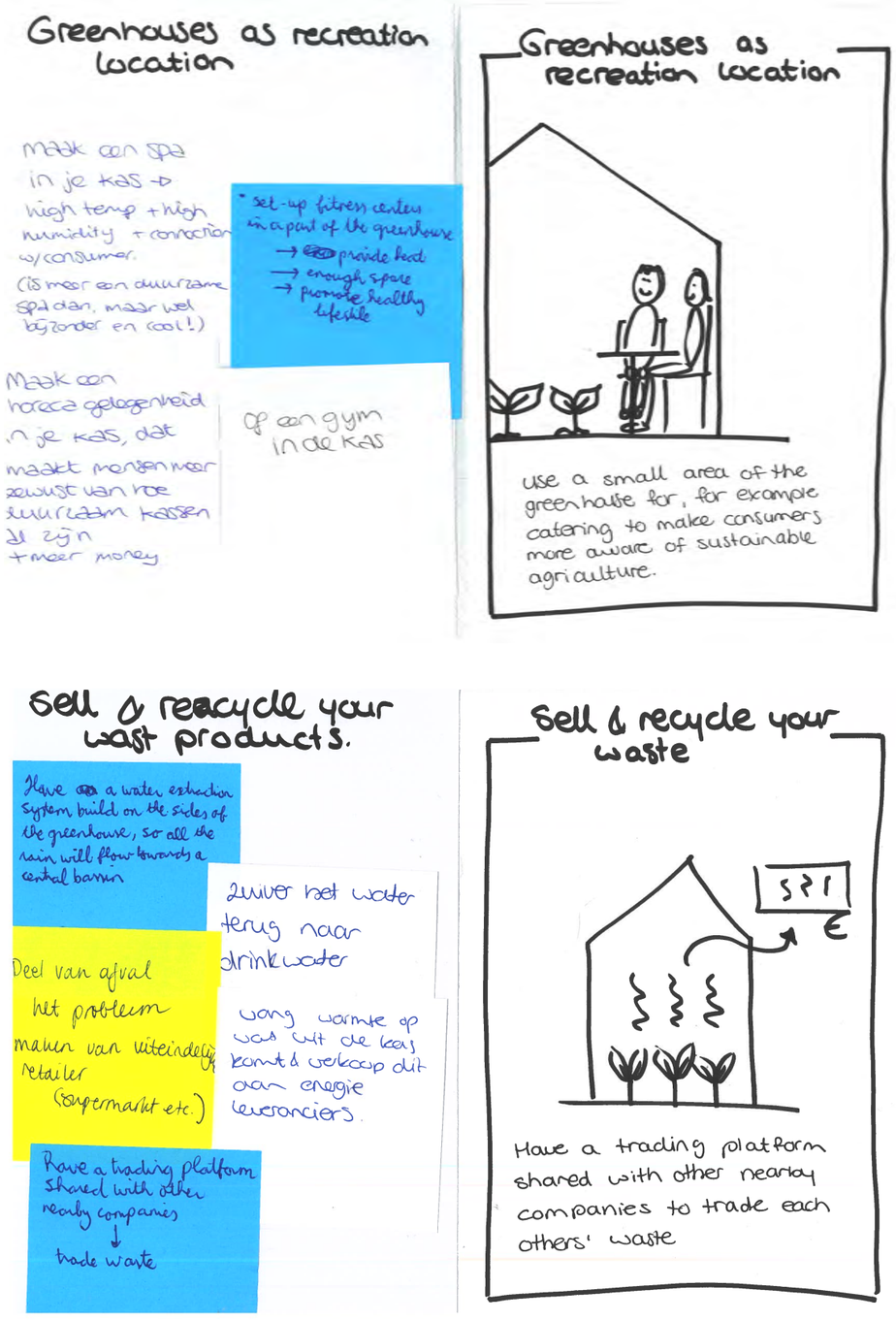


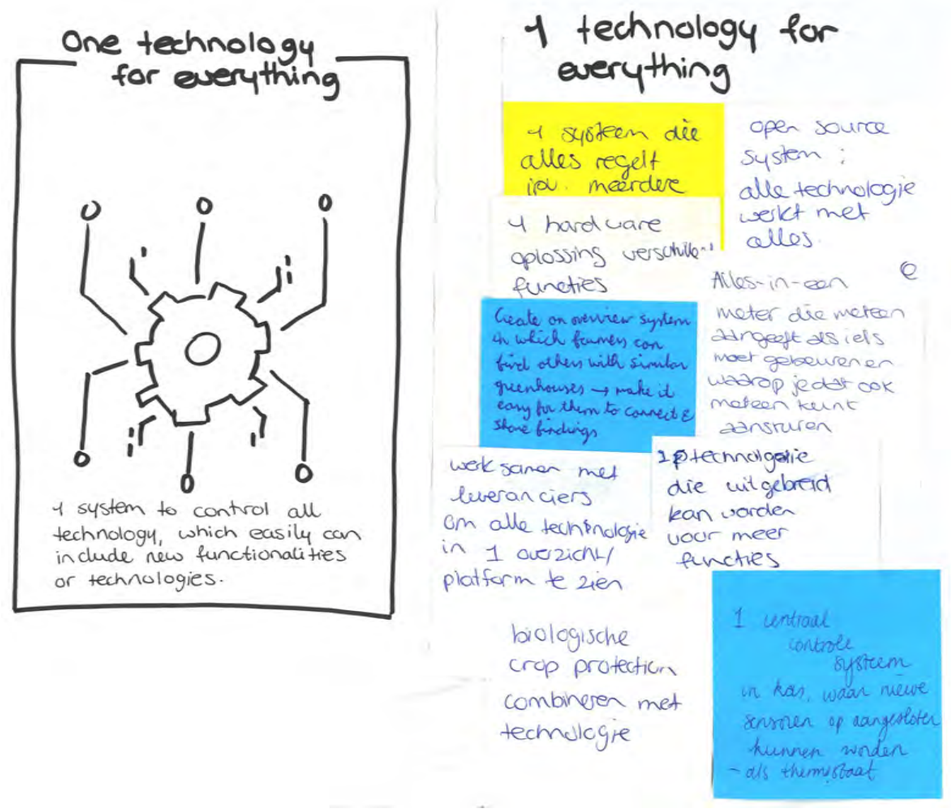


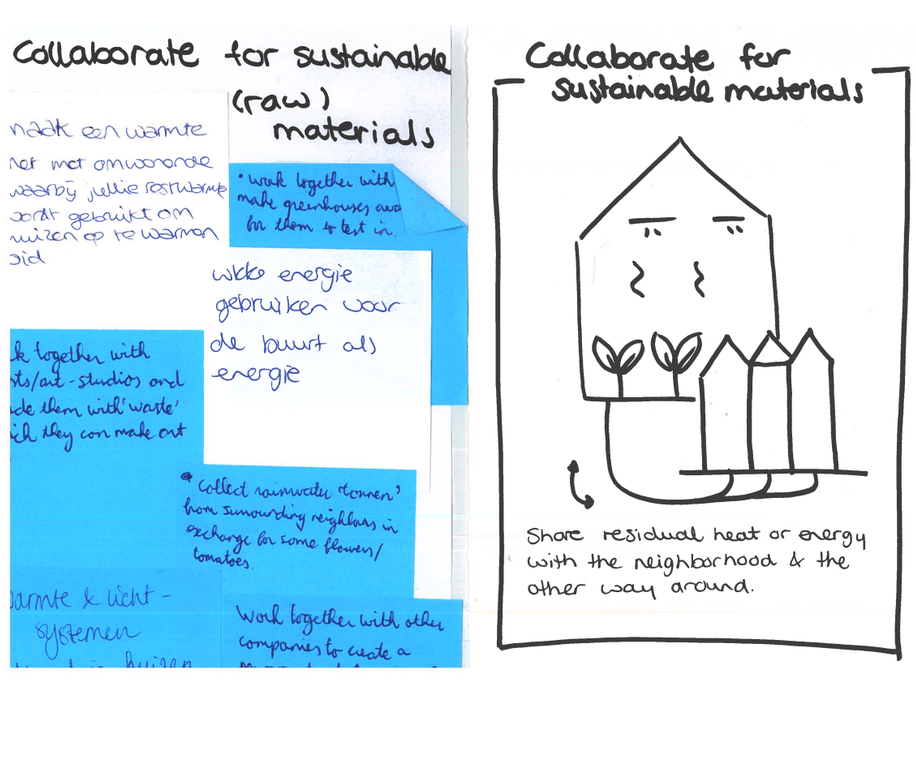




Appendix D: From post-its to idea cards







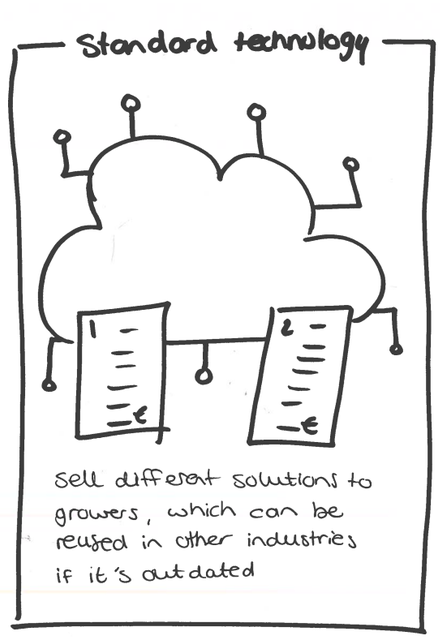
'Standard' technology

verschillende pakketen van oplossingen afh. vraag teler.

verkoop technologie na gebruik aan akkerbouw of andere industrieën

Obligate all farmers to only use one type of heater

Technologie ook voor landbouw & veeboeren??



Monitoring

per plant alleen de input gebruiken wat echt nodig is

Create a drone that checks for humidity, light status and heat and at the same time can work as a 'rain shower'

constant katen zien in rode & groene ballegjes

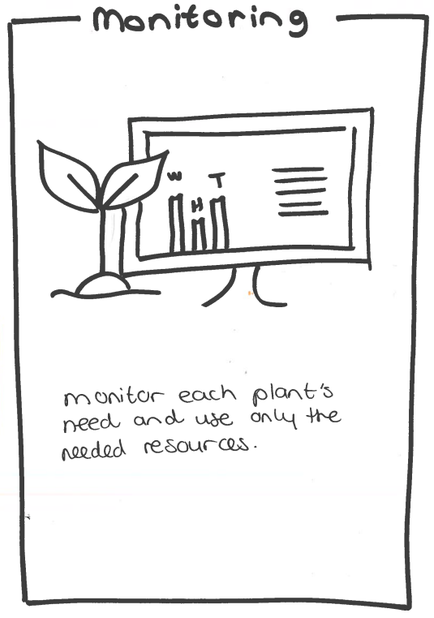
Use a smart system that automatically opens windows of the greenhouse when it becomes too hot

track data per tafel planten & genereer optimale omstandigheden

experimenteer wat een tomaat minimaal nodig heeft

AI die weet wat er nodig is per plant om perfect te

Track which part of the greenhouse uses most water and transport it to the part that uses it least



Growing-as-a-service

alleen nog maar technologie as-a-service

LED [illegible] as-a-service

betalen per keer dat het aan gaat

Create a subscription model for users → every month they can pick up a 1m² of products

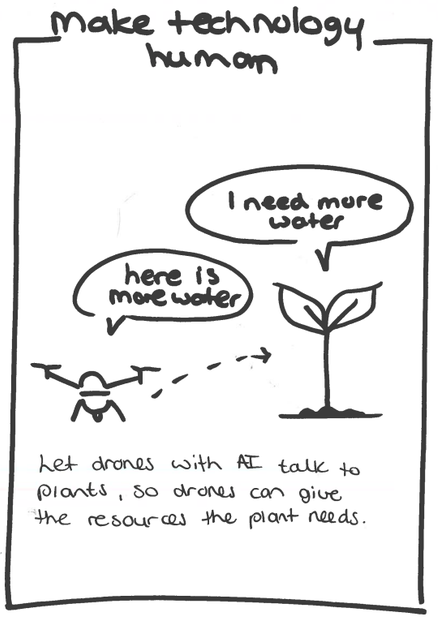
Make technology human

geef technologie mensen namen om er meer aan gehecht te raken

laat technologie tegen je praten als je er langs loopt

AI drones die een band opbouwen met je planten en daardoor beter weten wat ze nodig hebben

Technologie die focust op "emotie"

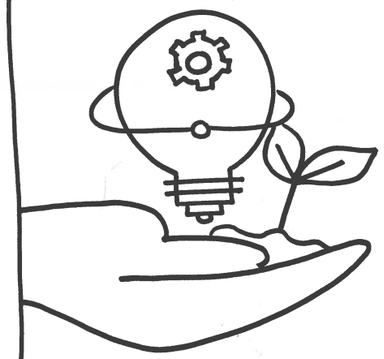


Innovation service

Een extra duurzaamheids label van een programma een
→ service voor beroerder ze altijd up to date zijn
→ consument weet dit en betaalt meer voor het product

duurzaamheids programma waarbij telers per jaar geld betalen en daarmee zij elke keer nieuwe innovaties mee krijgen

Innovation service



Sustainability program which has a yearly fee, but the guarantee to be assured to get the newest innovations

Only local food

Ga samenwerken met Tess en doe iets met seizoens-groente

Elke periode van jaar iets anders telen??

Lokale verkoop realiseren → drink supermarkten lager

maak een deal met plaatselijke supermarkten voor direct & meer lokaal verkoop

Produceer alleen voor nederlandse bedrijven en werk met NL supplyers

closer connection with nearby retailers and supermarket, so the products do not have to travel far

Graaf werkruimers alleen nog maar

Only local products

Create closer connections with nearby retailers and supermarkets to lower the margins and let consumers buy more local products.

Using Sunenergie

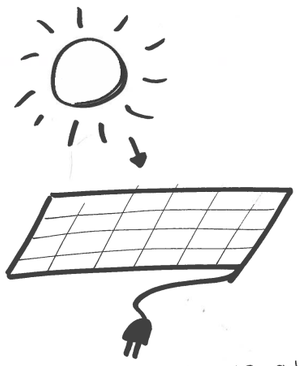
alle Producten op zonne energie

elk product op zonne energie (self ladende producten)

Glas wat zonne-panelen is waar wel zonlicht door heen komt

zonne-energie & regenwater & warmte opslag

using sunenergy



Let all products use only sun energy (or other renewable energy) and buy sun panels which are integrated with glass to increase the amount of sunenergy

less technology, more biology

Regenwater!! opslaan + gebruiken

Creer cyst velden principe

Alle rest energie hergebruiken voor andere dingen

kijk op je de rest-stof van de plant kunt verbranden ipv gas (bio massa), levert bezuinigingen op de gas rekening

biologische pesticiden & minder technologie

technologie weg

Ik denk dat standardization in

Less technology more biology

Use less technology and more inspired by biology

Consumer education

Rondleiding door kas — educatie
↓
interactief?
↓
kas in staat puur voor educatie

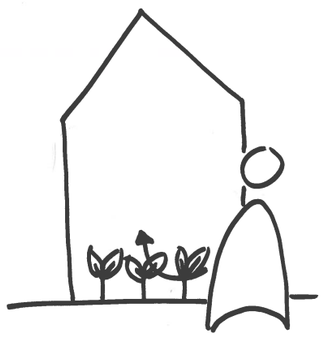
hoeveelheid vervuiling laten zien in eindproduct
→ zwarte gebera's & blauwe tomaten gfeo?

Have people pick up flowers/tomato's themselves

geef men inkijk in de digitale kas. wat gebeurd er precies.

'Hire parts of the greenhouse to people that wont to have a 'moestuintje'
→ they will also find new ways of improvement

Consumer education



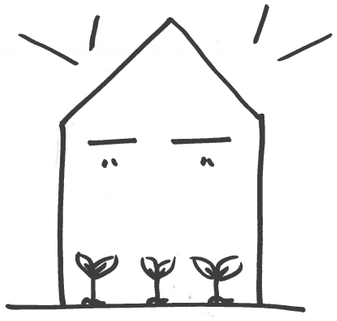
Educate the consumer about the sustainable agriculture. For example: educational sessions in greenhouses for people who don't know anything about agriculture

Entertainment

Lichtshow ipv vervuiling

Spelletje motten drones om interactiviteit te laten zien
OF: kinderen leren beestjes in groenten wanderen

Entertainment



use light waste from the greenhouses as entertainment

make special products

geef duurzaam geteelde groenten iets speciaals waardoor je herkent dat het duurzaam is en dus meer geld oplevert (bijv andere kleur ei)

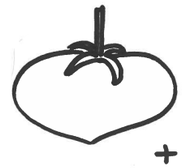
Producten als exclusief iets aanbieden/verkopen

Geef groenten meer smaak en kwaliteit waar de consument meer voor over heeft

Hartjesvorm tomaten voor valentijn

Groentes met meer voedingsstoffen waardoor je minder hoeft te eten

Make special products



+ ee

Give sustainable products something special, so consumers can easily see it's sustainable and are willing to pay more.
→ for example heart tomatoes for valentinesday

Consumer actively involved

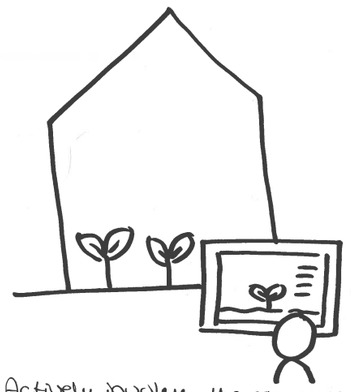
Communicatie tussen supermarkt & teler → zichtbaar voor consument in bloemenschap "over 2 uur nieuwe bakken bloemen

'let people bet on which tomato will grow first, which one will be the biggest, heaviest etc'

Adopteer-een-plant waarbij de eindgroninor zelf virtueel zijn plant bij kashouden en je AH weg concurreert

live stream van 1 plant; van zaad tot

consumer actively involved



Actively involve the consumer at the growing process. With for example a possibility to adopt a plant, where they see the growing progress, and buy it directly at the grower when ready

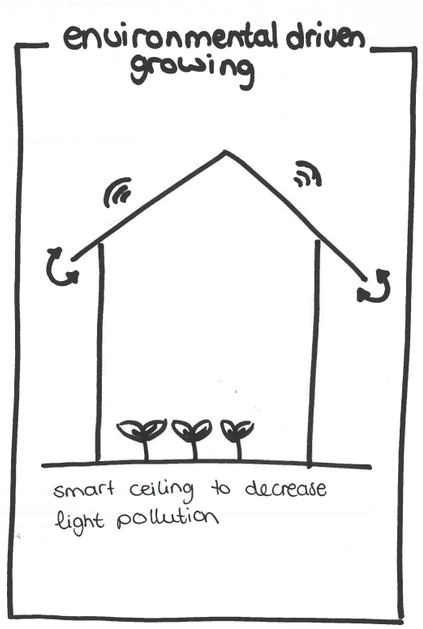
environmental driven growing

Vertical farming met gebruik van spiegels om alle planten licht te bieden

Licht
↓
verlichting voor omgeving
↓
minder kas in stad of dorp

have greenhouses on roofs of tall buildings or on certain floors of buildings
↓
cities have in general much more heat

Het plafond als een soort smart-material dat overdag glas is en zon binnenlaat en 's nachts gesloten is met spiegel zodat lamp-licht binnen blijft



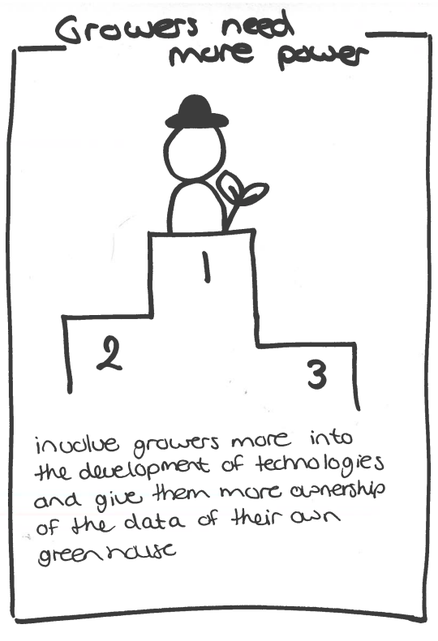
Growers need more power

Teler eigenaar over eigen data die hij doorverkoopt aan supplier om hem te helpen

al in stadia 1 vragen of er behoefte aan is

Hulp bieden zelf ui te ontwikkelen → Teun & Gijs als expert ipv dien

de teler aan de overleg tafel over technologie



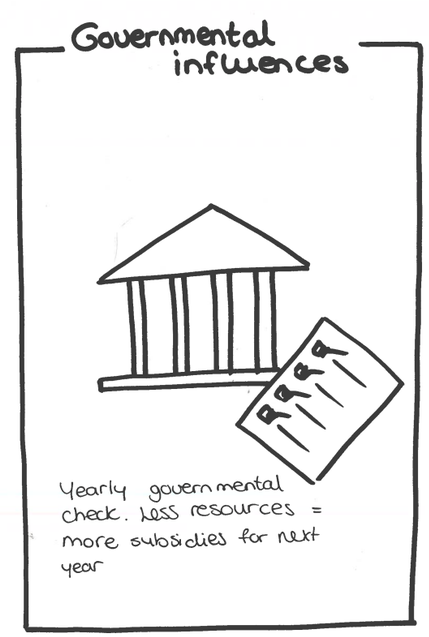
Government influences

verbied crop control

alleen bio of ~~technisch~~ toegestaan

Jaarlijkse check:
minder resources
meer overheids subsidies?

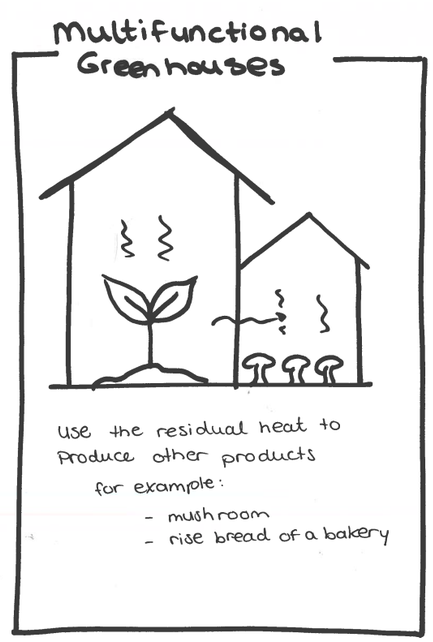
Kennis overheid gebruiken → "consultant" vanuit overheid



Multifunctional Greenhouses - Products

Gebruik warmte om producten te maken die hoge temp. nodig hebben → deeg gisten/ gist? paddenstoelen?

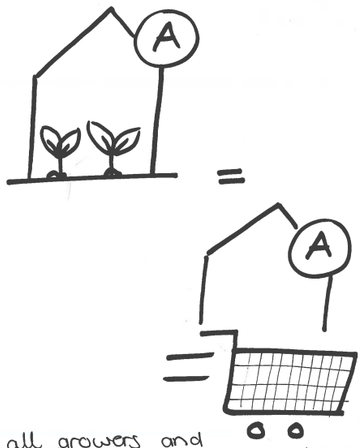
Bij lets ernaast telen wat het goed doet op onstandigheden



Sustainable public raiting

Gooi het systeem om:
Alle boeren en supermarkten krijgen een rating, en hoe duurzamer de supermarkt, hebben recht om van de duurzamere boer af te nemen

Sustainable rating



all growers and wholesales get a sustainable rating. Only sustainable supermarkets have the right to sell sustainable products.

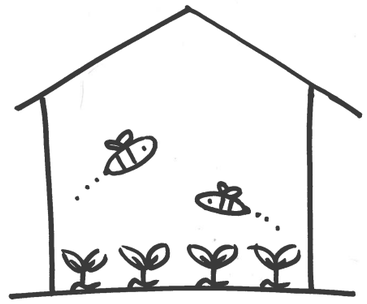
Natural ecosystem in the greenhouse

Find animals/insects that eat other insects, but not the crops

use of 'natural agents'

laat dieren in je kas rondlopen, die geven warmte en voeden af

Natural ecosystem in the greenhouses



Find animals / insects that eat other insects, but not the crops

use other industries' waste materials

Afval uit stad (horeca huishoudens) als compost telers?

with the heat from the greenhouses also for own homes/farms

s met fysiek afval & compost voor planten

maak gebruik van rest afval van kolen/gas/ CO_2 industrieen

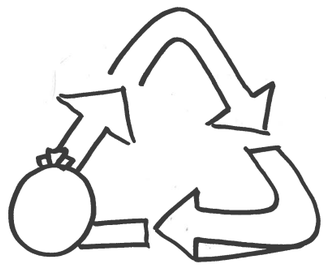
werk met biomassa ipv gas

ebruik CO_2 van ival van ndere industrieen

"Kipster ei" systeem (kijk omte googlen, geen idee)

erk samen met

Other industries' waste materials



Use waste of other industries as input for the crops.

For example: use biomassa instead of gas.

~~#~~ create more sustainable awareness

ingredienten tabel op eindproduct

licht £0,33
water £1,00
£

awareness

Je kunt alles bijhouden dus op de verpakking informeren wat de impact is van ~~het~~ de groente, als je dit kan vergelijken zie't men hoe duurzaam het is.

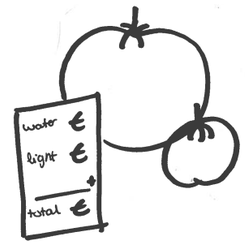
Stunt

stoppen telen (landelijk) bepaal producten (awareness)

Bloemen die alleen leven met resources die ze in kas hebben → bloemen gaan dood → awareness

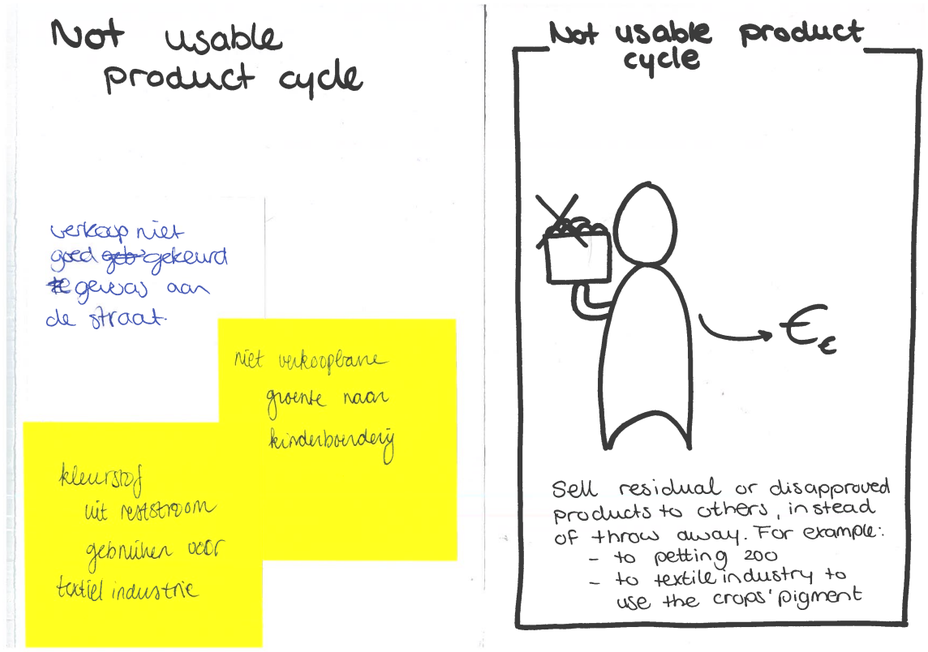
"Slechte" bloemen & tomaten

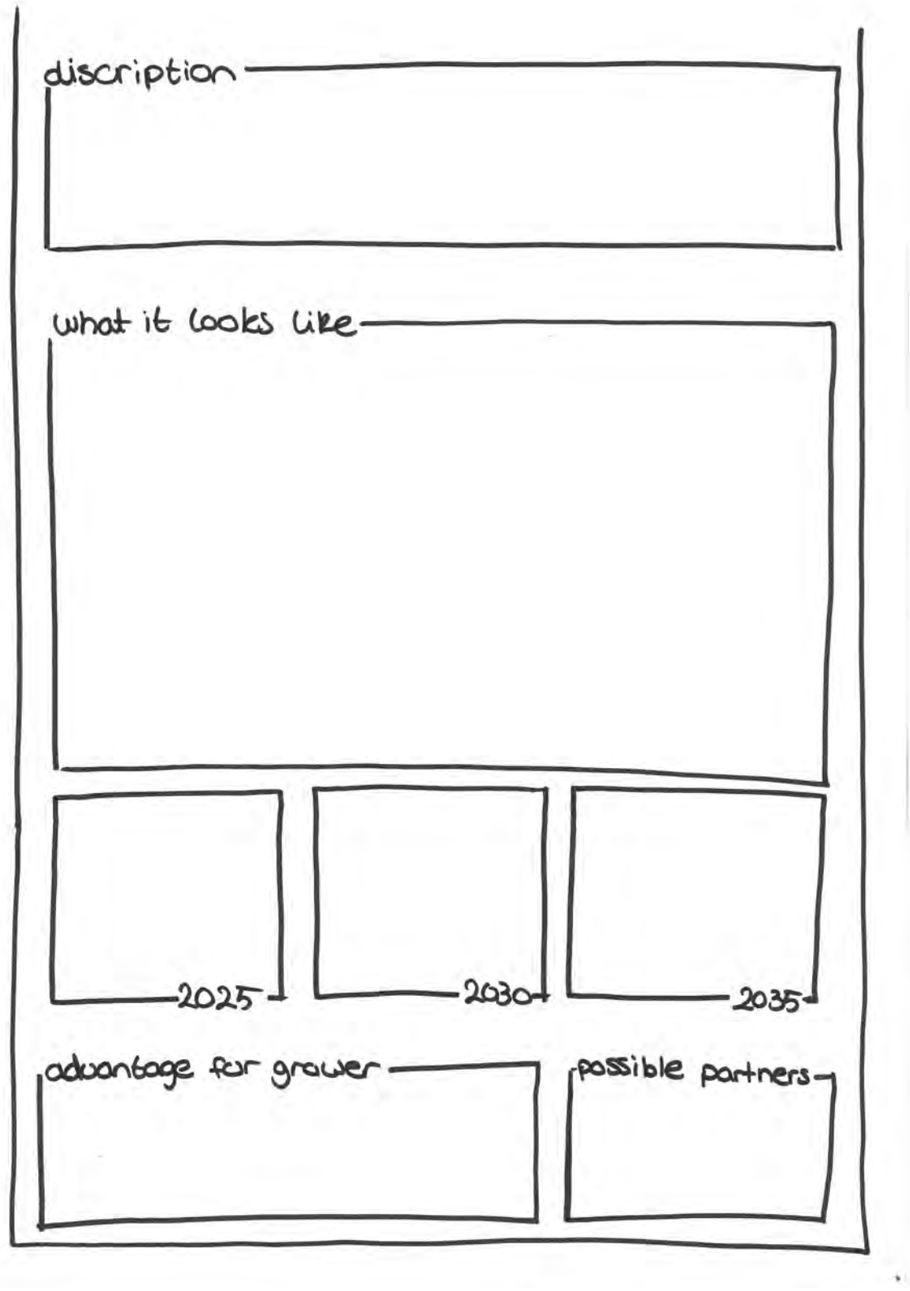
Create more sustainable awareness



inform consumers on the label of the product to show the sustainability costs.

Appendix E: Concept format





Appendix F: Background information for KPN employees

Challenge

How to successfully launch **sustainable IoT solutions** in the horticulture ?

Who did I spoke to?

Inside KPN

- Jan Rijk Vonk
- Titia Houwing
- Harold van der Hoeven
- Jacob Groote
- Brechtje Spoorenberg
- Hans Bodenstaff
- Dennis Groot
- Eric Oldenburger
- Ellen Aartsen
- Fabian de Prieëlle
- Han de Glint
- Chaoyi Zhang

Outside KPN

- Grower in Peppers
- Grower in Flowers
- Grower in Plants
- Grower in Tomatoes
- Grower in Tomatoes

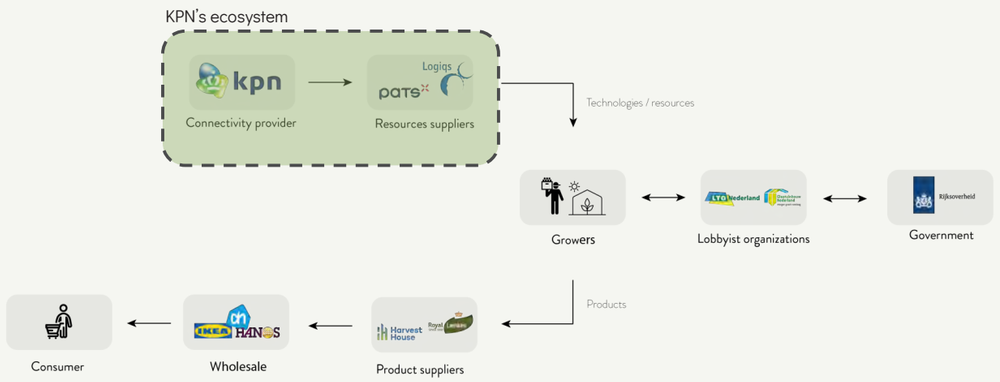
Sectors of Dutch agriculture

Arable farming

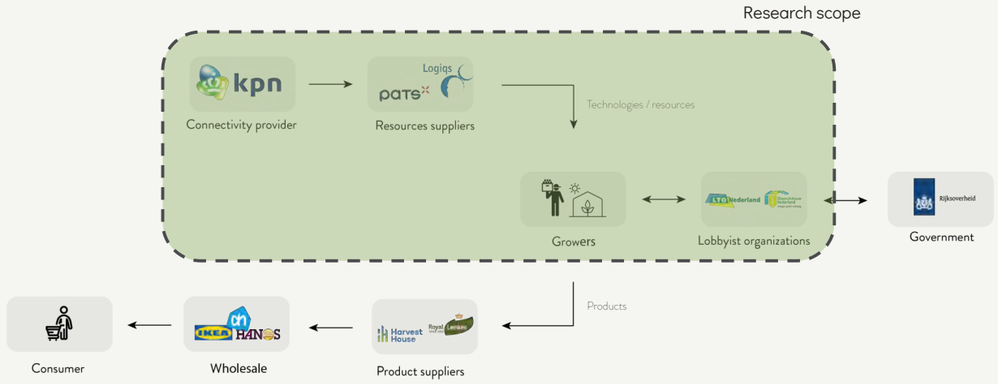
Horticulture

Livestock

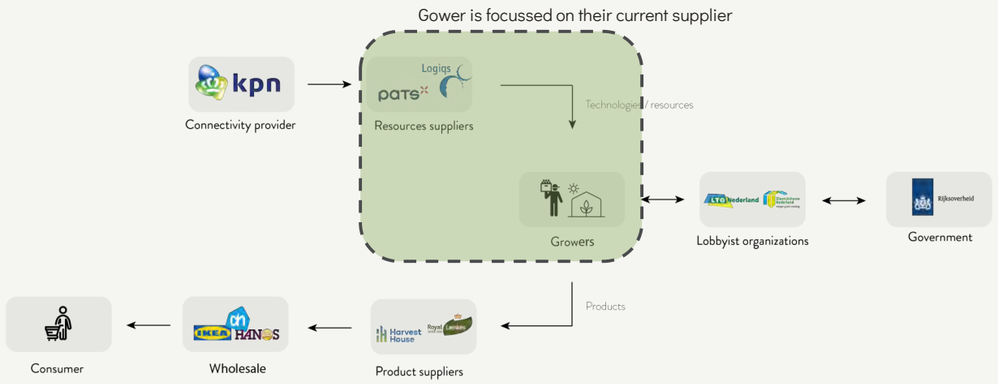
Current Supply chain



Current Supply chain



Problem for KPN



Competitors

Standard competitors of KPN:

Big ICT companies who could commit to develop digital twins for horticulture:

Biggest competitors in horticultural market:

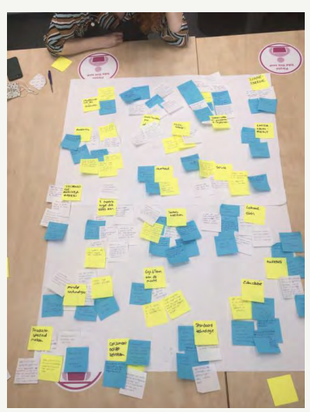
New start-ups which understand growers:

Challenge

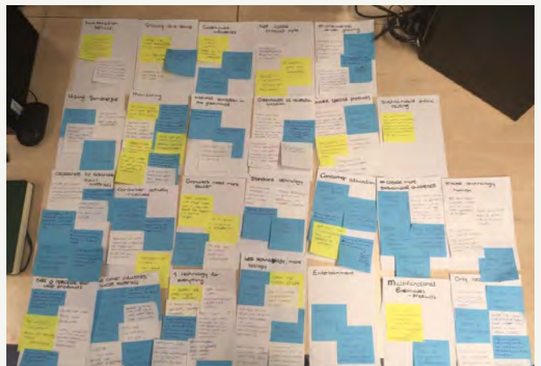
How to **apply IoT** to **improve the sustainability potential** in the horticultural sector?

Design for the growers

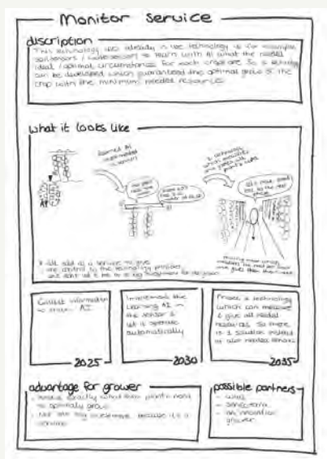
Creative session

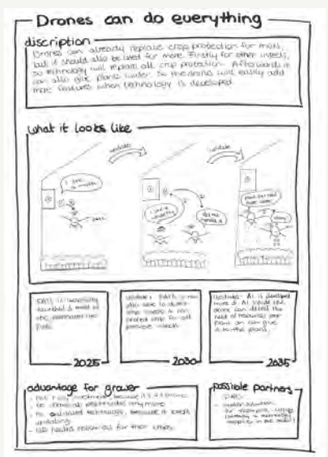


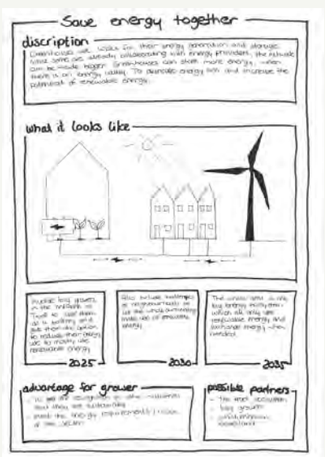
Creative session



3 concepts







Appendix G: Project brief

DESIGN FOR our future

4686

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Fisser
initials: D.J. given name: Dyantha
student number: 4363256
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):
IDE master(s): ( ) IPD ( ) DfI (★) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Erik Jan Hultink dept. / section: MCR
** mentor: Athanasios Polyportis dept. / section: M&CB
2nd mentor: Jeroen Cox
organisation: KPN
city: The Hague country: The Netherlands

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

comments (optional): Dr. Hultink will accompany me with his expertise in go-to-market strategies and his practical expertise in new product marketing. While Dr. Polyportis will accompany me with his expertise in IoT and sustainability.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Erik Jan Hultink date 05 - 02 - 2021 signature

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 18 EC
Of which, taking the conditional requirements into account, can be part of the exam programme 18 EC
List of electives obtained before the third semester without approval of the BoE

(X) YES all 1st year master courses passed
( ) NO missing 1st year master courses are:

name C. van der Bunt date 08 - 02 - 2021 signature CB

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: (V) APPROVED ( ) NOT APPROVED
Procedure: (V) APPROVED ( ) NOT APPROVED

comments

name Monique von Morgen date 16/2/2021 signature MvM

Initials & Name D.J. Fisser Student number 4363256
Title of Project Implementing sustainable IoT solutions in the agricultural sector at KPN

Implementing sustainable IoT solutions in the agricultural sector at KPN — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 08 - 02 - 2021 — 09 - 07 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Nowadays, the Internet of Things (IoT) is becoming more present in human's everyday lives (Muangprathub et al., 2019). IoT ensures physical objects, which are equipped with sensing, actuating and computing power, to perform their task in while being connected to the internet (Lakhwani et al., 2019). The ultimate goal of IoT is due to IoT everything is connected all the time, everywhere for everyone; or as International Telecommunication Union (2005) states: "IoT is the connectivity for anything". IoT is used in different sectors from smart buildings, to smart transportation or smart health, within this project I will focus on the sector of smart agriculture.

In the agriculture IoT is embracing to make the production more efficient and sustainable (King, 2017). Dutch farmers are striving for a more efficient farm. Within greenhouses, there is an indoor controlled environment. In this environment there are different emission reduction factors which indicate the sustainability of the technology, these emission reduction factors are: environmental control, resource/process efficiency and pest control (KPN, z.d.).

KPN is a leading telecommunication and IT provider and sees itself as "the green connector", by being the most Nowadays, the Internet of Things (IoT) is becoming more present in humans' everyday lives (Muangprathub et al., 2019). IoT ensures physical objects, which are equipped with sensing, actuating, and computing power, to perform their task while being connected to the internet (Lakhwani et al., 2019). The ultimate goal of IoT is: due to IoT everything is connected all the time, everywhere for everyone; or as International Telecommunication Union (2005) states: "IoT is the connectivity for anything". IoT is used in different sectors from smart buildings, to smart transportation or smart health, within this project I will focus on the sector of smart agriculture.

In agriculture, IoT is embracing to make the production more efficient and sustainable (King, 2017). Dutch farmers are striving for a more efficient farm. Within greenhouses, there is an indoor controlled environment. In this environment, there are different emission reduction factors that indicate the sustainability of the technology, these emission reduction factors are: environmental control, resource/process efficiency, and pest control (KPN, z.d.).

KPN is a leading telecommunication and IT provider and sees itself as "the green connector", by being the most sustainable telecommunication company in the world. They help their clients to be more sustainable by providing sustainable solutions to create an even more sustainable IT landscape within KPN (KPN, z.d.). To achieve this more sustainable IoT landscape they focus on Sustainable Development Goals 9, 11, and 12 of the world health organization (WHO) (see figure 1). Within the collaboration with their clients, KPN fulfils the role of the expert data and connectivity within the field of technology.

Sources:
International Telecommunication Union. (2005). The Internet of Things. Retrieved from https://www.itu.int/osg/spu/publications/internetofthings/InternetofThings_summary.pdf
King, A. (2017). Technology: The future of agriculture. Nature, 544(7651), S21-S23.
KPN. (n.d.). Duurzaamheid. Retrieved 27 January 2021, from https://www.overons.kpn/nl/kpn-voor-nederland/duurzaamheid
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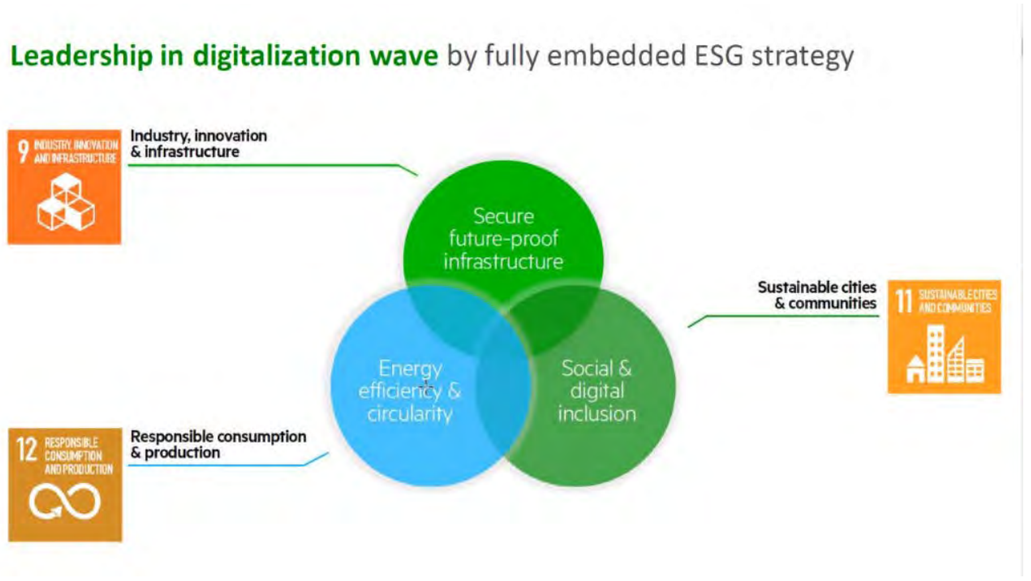

image / figure 1: KPN's focus on Sustainable Development Goals of the world health organization

TO PLACE YOUR IMAGE IN THIS AREA:
- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:
- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
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PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

IoT products and services are becoming more and more popular in the market. Nowadays, these products and services are mainly focused on efficiency and productivity. As sustainability is also becoming more important, and as IoT has the goal to connect everything I'm interested in how this technology connects sustainability and technology. Beginning at the problem of the customer, designing a solution for this problem and launching it on the market is a big process. I'm curious about combining these aspects of IoT, sustainability, and launching a product/service on the market.
At KPN there are a lot of products/services in development that make use of IoT. KPN doesn't have the expertise to design one solution by their selves, therefore their IoT solutions are provided by an ecosystem of different stakeholders. The problem of different stakeholders within an ecosystem is that different stakeholders only look to the solution based on their interests. This leads to oversee the interest of the ecosystem as a whole, which will decrease the potential of the outcome of the IoT solution. This is where my role is introduced in combining IoT, sustainability, and launching a product/service on the market while looking at the solution independently for the benefit of the outcome of the IoT solution.

Therefore the following problem is coming up:
How to successfully launch a sustainable IoT solution in the agriculture sector which is part of an ecosystem of multiple stakeholders?

Facing this problem the following sub-questions are coming up:
- How to create an ecosystem where every stakeholder is satisfied with their role?
- What is the process from IoT use cases testing's phase to the market?
- How to propose a sustainable proposition while launching an IoT solution?

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Design a process to launch a sustainable IoT solution with multiple stakeholders. I will focus on one IoT solution and design an ecosystem and a go-to-market strategy for this solution.

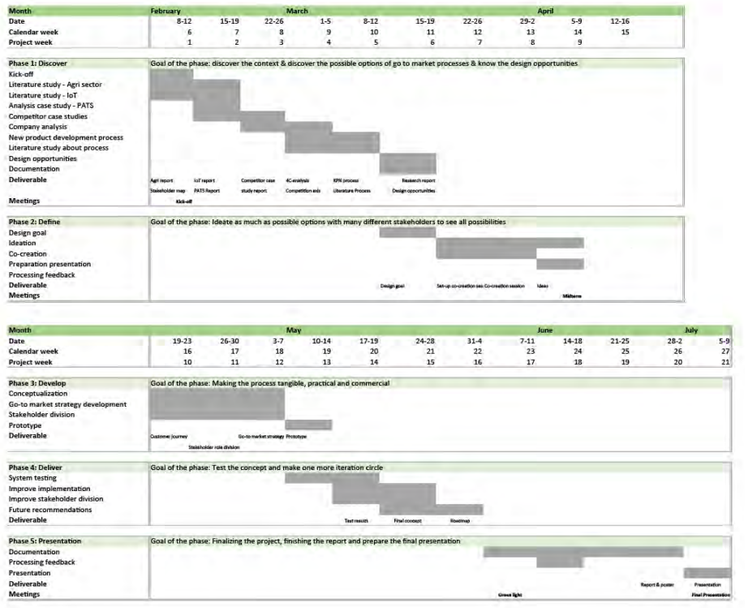
For my project, I will first research solutions that are already on the market by KPN and other companies. After that, I will focus on 1 solution: PATS, which are drones, which are Automating Insect Control. These drones control harmful insect populations without using any pesticides and help farmers to mitigate the risks of crop damages.

This solution is already in the testing phase and has already multiple stakeholders involved. This ecosystem is still hard to understand because of its multiple stakeholders and it's not clear yet how to make it feasible enough to put it on the market. By designing this ecosystem and go-to-market strategy, I will be involved with all stakeholders to let them all be satisfied with their added value to the ecosystem. I will convert the process of my design into advice for KPN on how to bring other sustainable IoT solutions within an ecosystem on the market.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 8 - 2 - 2021 9 - 7 - 2021 end date



I will work full time, 5 days a week, on my graduation project. After the midterm, I planned to take a week off. Besides that, I took a time span of 21 weeks, so I still have 5 days in between to prevent an overflow of work pressure and/or be still able to take days off for example on national holidays.

In the planning, it looks like I'm only documenting at the end of my project. However, I plan to write each week something about my process to overcome a lot of documentation at the end.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

During my master's program, I most liked the courses DSP and BPC, therefore I like to combine elements of these courses within my graduation. Looking back at BPC let me think about what I wanted to learn more. I like to learn more practical skills. Therefore I like that this graduation assignment is more targeted to the commercial side of innovation. For my project I have 3 personal learnings I want to develop:

1. Practical skills
I want to learn more practical skills. I mentioned in my master I have a strong focus on research. However, in a company, I noticed that if I talk about what I'm good at, this is still too vague and theoretical. Therefore I would like to learn how I can translate theoretical knowledge and designs into practical, more tangible designs.

2. Sustainability
Sustainability is a topic that is becoming more and more important within the world. I never deepen myself into sustainability in my previous projects, therefore I like to learn more about sustainability. I want to learn how to implement sustainable innovations within the market, where sustainability isn't the main focus. I would like to learn about how to make the sustainable value of innovation just as important as the economic value.

3. My project
Another personal ambition for this project is to set up a strategic design project on my own, where I can take the lead. I like to learn how to approach strategic projects on my own because in my master I only had group projects. Besides that, I want to take the lead and also actively ask for help when needed. I know that I find it hard to ask for help even if I know I need it, but then I still try to solve it myself. In this project, I would like to take more the lead and ask for help, if I need to. Besides that, I would like to test my leadership skills also on another way by setting up at least one co-creation session to learn how to accept help, create ideas with outsiders of my project, and test my skill of practical communication.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name D.J. Fisser Student number 4363256

Title of Project Implementing sustainable IoT solutions in the agricultural sector at KPN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