THE FUTURE OF FLORICULTURE LOGISTICS

A logistic design for the floriculture chain for the year 2025, incorporating feasible trends and developments

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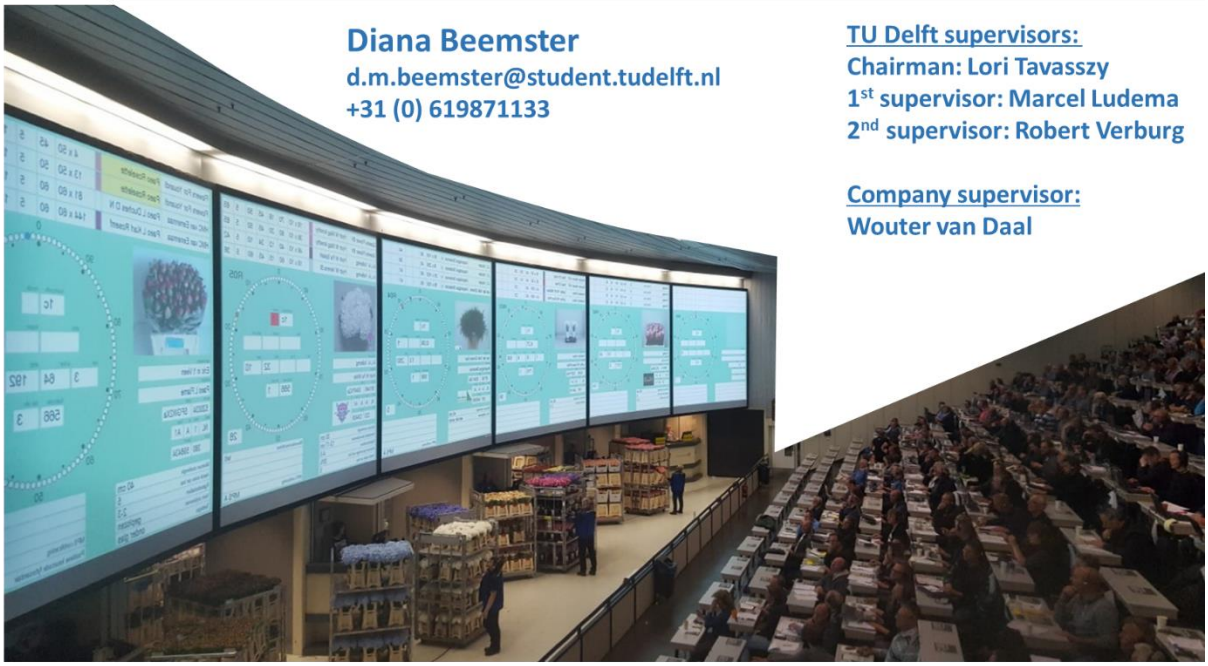

Royal Flora Holland

TU Delft

THE FUTURE FLORICULTURE LOGISTICS

A design for the logistics of a flower auction house on the mid-term, incorporating feasible trends and developments

Master thesis project report

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Preface

When I was young, I have seen an episode of the children television duo Bassie en Adriaan filmed in the crazy logistics of the flower auction house at Aalsmeer. This enormous area with moving trolleys, trucks and machines directly interested me. At the end of 2016 I got in contact with this largest flower auction house in the world, Royal FloraHolland, to write my thesis in combination with an internship in Aalsmeer. This master thesis project 'the future floriculture logistics' has been performed to fulfil all requirements of my master Management of Technology at the TU Delft.

At the start of the project it was hard to define a clear subject for my thesis that really interested me. It is in my character that I like almost everything, so it was hard to find one specific subject to focus on for the next six months. After the first month of internship I finally found a subject. This subject changed a few times due to discussions with my supervisors at the TU Delft and at Royal FloraHolland. After almost two months my thesis started to form into its final direction.

I would like to thank all people that helped to make this project a success. They all supported and motivated me to fulfil and improve this project, with this master thesis as the final result. I would like to thank my supervisors at Royal FloraHolland, first Wenke Leisink and after she left Wouter van Daal. They helped me with this project and gave me the opportunities to get a perfect experience of the work at Royal FloraHolland. They also gave me tasks in different projects at Royal FloraHolland, which made it easier to clear my mind during the writing process.

I also want to thank my supervisors at the TU Delft Lori Tavasszy, Marcel Ludema, Robert Verburg for everything they have done to help me completing this thesis. They always gave me relevant feedback which was very useful to improve my report. Next to this I want to thank them for their flexibility, helpful discussions, experience and information that helped to improve the quality of this thesis.

Lastly I want to thank my proof readers, friends and family who supported me to finalize this project. Especially the comments of Rijan van Druten, Ineke Groot Baltink and Thomas Hajonides helped me to optimize this report. I also want to thank my colleagues at Royal FloraHolland who were always willing to answer questions and understood when I had to spend extra time to my thesis.

Diana Beemster
September 2017

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Executive summary

Throughout this report a logistic design for the floriculture supply chain from the growers to the buyers of the flower auction is developed to be feasible around the year 2025. Trends and developments in and around the floriculture market as consolidation of transport, shift in customer demand and the Internet of Things are plotted on a hype cycle to test which trends are feasible in this market on the mid-term. This analysis in combination with a relationship analysis results in two solution directions that include a lot of other trends and developments and could be feasible to implement before 2025. Those two solution directions are a virtual storage and a hub-network and are elaborated into conceptual designs. These designs operate on different levels and could be combined for a future logistic design. In this final design, storage hubs and transit hubs will deal with physical products with a focus on storage of goods for just in time delivery and consolidation. The virtual storage is represented in a commercial and transportation platform. On the commercial platform products can be sold at any time and place in the world even if they are not physically located in a storage. The transportation platform will take care of consolidation of product flows and the assignment of transport orders to logistics providers. The combination of those two conceptual designs with inclusion of the described trends is expected to be feasible before 2025, however, the implementation in this complex floriculture market will take a lot of effort and trust from all stakeholders.

Summary

Nowadays, in the floriculture market the auction house Royal FloraHolland in the Netherlands is the main operating partner amongst all growers and wholesalers. Today's situation shows a leading position of the Netherlands in worldwide floriculture market trade. However, due to the growing e-trade market and online connections, direct flows of floriculture are increasing, resulting in a potential risk for the flower auction to lose their value-adding activities.

The scope of this thesis is on the floriculture supply chain from the growers until the buyers of the auction house. Focus is on logistical value-adding activities in this part of the supply chain. This thesis describes the research performed to trends and developments in the floriculture supply chain, and proposes for a logistical design for the role of the flower auction in the future supply chain on the mid-term until the year 2025.

Today the central flower auction has a clear value propositions:

- It provides a marketplace for sales,
- with financial guarantees where the growers receive their money within 24 hours although the transactions at the buyer's side are not arranged yet;
- it provides an extensive logistics and distribution process.

In the future those values propositions are not necessarily leading. Because of upcoming trends and developments in the floriculture supply chain, there is a clear need for change:

- Customer demand is moving towards 24/7 hours sales, instead of one fixed clock sales moment per day;
- the flower auction as a central point of sales by means of a physical clock auction, results in many inefficient transportation flows worldwide, which are unsustainable and cause high cost of waste, this could be improved.

Smaller companies performing direct sales, supported by web based technologies and platforms are faster to adopt new solutions which could become substitutes for the activities of the auction house. There is a risk that a central flower auction might lose its leading current position soon. Therefor there is clear need at the client (Royal FloraHolland) to develop a longer-term vision (past 2020) for the future positioning of flower auction in the future logistics of the floriculture chain. A redesign of the logistic operations in the chain that is feasible and realistic to implement on the mid-term (for 2025) is needed.

The project scope with respect to the supply chain will be visualized as the logistic activities from the growers until the buyers of the flower auction house, being wholesalers or retailers. This means that retail strategies and applications towards the consumers are out of scope for this thesis. Other constraints for this design are that the design needs to be feasible on the medium term around 2025. This means that only existing trends and technologies with a high maturity level on the mid-term can be incorporated in the final design.

In this thesis the trend of this changing customer demand and many more trends will be analysed to find improvements for the logistic flow on the mid-term within the floricultural supply chain. This comes together in the following problem statement:

To develop a feasible logistic design for the flower auction Royal FloraHolland for the year 2025, based on the maturity of technologies and trends in the floriculture market.

The thesis is built up in two parts, A and B, with both different methods. In part A research will be performed into trends and developments in the floriculture market as a basis for part B. Part A will

be a literature study and will consist of stakeholder consultations in order to collect all inputs, constraints and requirements that are needed for a feasible design. Requirements and objectives for the design will follow from part A together with a feasibility check of each trend on the maturity to be implemented on the mid-term. Part B represents the design part based on the method of Dym and Little (1999). This part will elaborate on two conceptual designs and combine them into a future floriculture logistics design. Final deliverables will be accompanied with implementation directions, an evaluation of the final design, discussion and recommendations.

DaVinc^{3}i: Consolidation Collaboration Coordination Virtualization	**Royal FloraHolland:** Virtual storage Autonomous vehicles 24/7 delivery Virtual marketplace Paperless More demand driven More direct flow
Interviews: Hub-network Track & Trace Changing demand 24/7 orders Internationalization	**New technologies (other markets):** Vertical farms Internet of Things Cold chain Blockchain Smart Robots

Figure 1, List of described trends and developments

In part A, trends and developments in technologies, logistics and ICT, both in the floriculture supply chain and in other markets, are investigated and requirements for design are given. These trends are evaluated on their possible contribution to improve the floriculture supply chain and their feasibility to be implemented on the mid-term (before 2025).

The following trends, Figure 1, are described and analyzed, with the origin of the trend in the title. From this analysis some main trends and developments became clear: consolidation, direct flow, track and trace and the more demand driven chain with a storage function.

Using the Gartner hype cycle the trends are plotted in floriculture hype cycle to visualize market maturity of each trend. Mainly the trends from DaVinc3i, Royal FloraHolland and interviews are market mature before 2025 and could possibly be incorporated in the logistical design. A relationship analysis shows how trends are related to each other and which trends are required to be performed before other trends can be implemented. This analysis results in a group of initiating trends, linking trends and resulting trends. Those groups of the trends are plotted in dependency diagrams to show which trends are prerequisites for others. Six linking trends came up from this analysis, from which two are feasible and final in line. Feasible and final linking trends in the diagram are virtual storage and a hub-network. Those trends are called solution directs and elaborated into conceptual designs in part B. Demands and trends on different levels are formulated and differentiated in need-to-haves and nice-to-haves requirements for the final floriculture logistic design on the mid-term.

Conclusion part A

From the combination between the hype cycle analysis, the relation analysis and the dependency analysis on the trends and developments, a few conclusions can be drawn. The floriculture hype cycle showed that not all trends will be feasible on the mid-term. The relation and dependency analysis showed that some trends that, according to the hype cycle, are market mature before 2025, are so much related to long-term trends that they are not feasible on the mid-term. This analysis results in two feasible solution directions that could be combined with the design requirements into two conceptual designs.

Concept 1: Virtual storage

Virtual storage is a function, different from a physical storage, where flowers can always be sold. At any location the flowers are virtually in the storage even if they are on transport or still in the garden. The final location of the virtual storage will be a physical storage, where the flowers will stay until their lifetime runs out. This physical storage location could be located on an auction house location.

This virtual storage function will be enabled by a sales platform where products are offered for sale since they are on the garden.

A very important reason for a change towards a virtual and a physical storage is because of the changing demand towards a more 24/7 or just in time delivery. For the operation of Royal FloraHolland the peak process can be decreased by the spread of labour supply. Next to those trends, other trends can also be applied in the virtual storage concept. Those trends are: virtualization, transport coordination, hub-network, paperless distribution, financial coordination and a (supply chain wide) track & trace function.

In a conceptual logistical design, Figure 2, is drawn how virtual storage could be applied to the flower auction system. The different flows of goods and the ownership are shown in the figure.

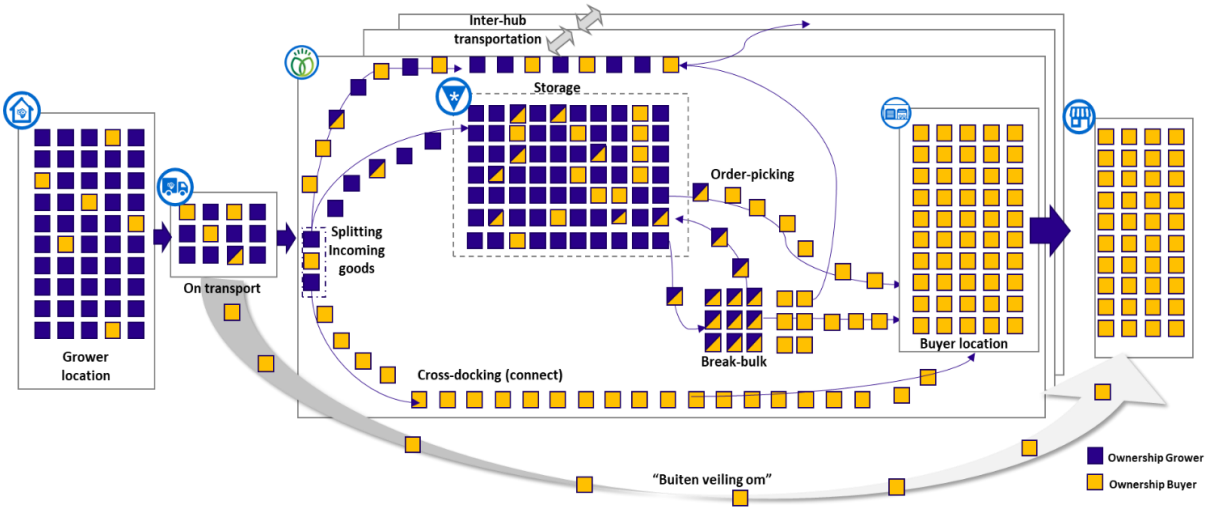

Figure 2, Final conceptual design virtual storage

Concept 2: Hub-network

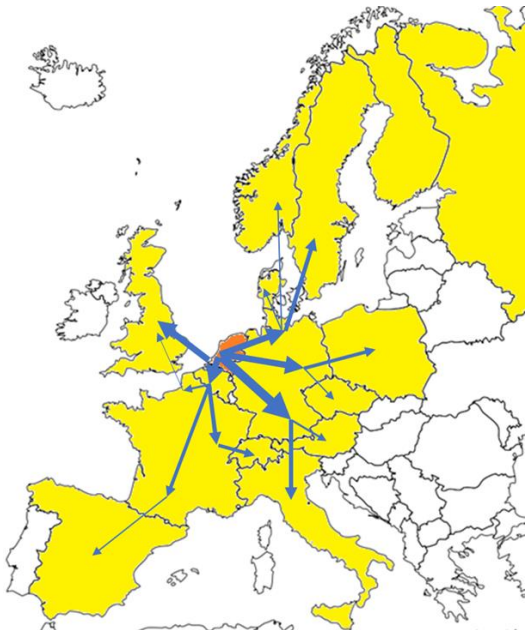

Figure 3, Consolidating flows with the hub-network

Just like the virtual storage principle, a hub-network can also function as a solution for the floriculture logistics on the mid-term. A hub-network can provide in a more effective supply chain by consolidation of product flows to reduce waste. Hubs need to be positioned in a strategic way in the world based on import and export numbers to be as effective as possible and to support for 24/7 product delivery to the customer.

The market becomes increasingly demand driven, which means that the supply chain will change from a push-driven chain towards a pull-driven chain. A hub-network is required to support a pull-driven supply chain.

A conceptual logistical design is drawn, **Fout! Verwijzingsbron niet gevonden.**, making the effects of a hub-network for the floriculture market and flower auction system, visible. Hubs could be created in the Netherlands and other countries that export or import flowers.

Final design: Future floriculture logistics design

As a next step, both conceptual designs have been combined into a future logistics design for the floriculture market. In the combined design a major change to the current position of a central marketplace hub becomes visible. When the virtual storage function will be applied on the floriculture market, and more goods will be sold before they enter a distribution location, the need for a physical marketplace decreases. Next to this, a requirement for the virtual storage is to have an online platform on which all goods are offered for sale. In fact, this online platform takes over the role of central marketplace hub as a virtual market place where sales take place.

Hubs like Aalsmeer and Naaldwijk receive products from growers, they will both have a physical storage function for goods to be sold. Those hub-locations where products will be waiting to be sold will transform into storage hubs. There will be another type of hub on several locations in the Netherlands and in other export/import countries, which will be a transit hub, meant to consolidate product streams and arrange efficient transportation towards a storage hub or to the final destination.

An integrated design of both solutions is drawn in a schematic picture, Figure 4, and in a process flowchart of the future logistics design. This design will have its financial and cultural effects on the key stakeholders in the chain. Many things need to change. A logistic and financial platform for transportation and sales needs to be created. Besides this, all hub locations need to be renovated or created to fulfil its new role. This will take time and require a lot of effort, money and trust in other parties. At the other hand the invested money could be earned back with this design, since transport could become more efficient and less mistakes and faster routes could reduce costs.

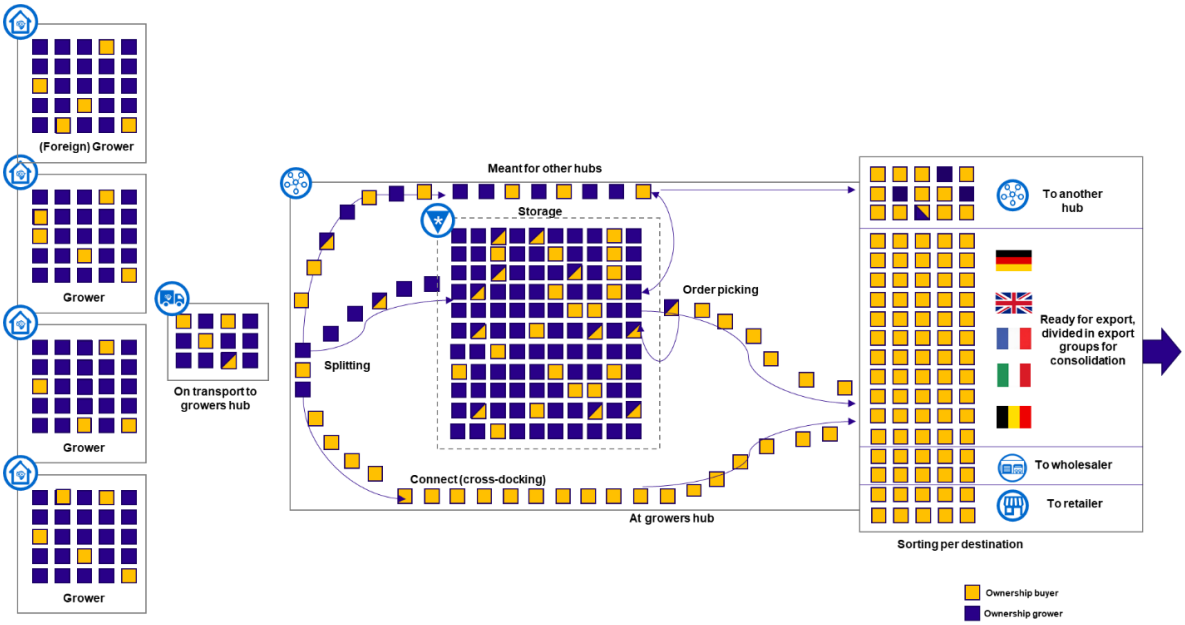

Figure 4, Schematic view storage hub in future floriculture logistics design

Most important stakeholders in the design are growers, the auction house, platform operators, buyers and third party logistic companies. The design will have effects on all stakeholders. The design implementation will be of high cost and effort. Online environments will change the activities and information flows of stakeholders and make the floriculture market and activities more international. Information registration by the growers will be more important in the new situation. New roles will become available in the design for example in operating the platforms. Transportation becomes more efficient and effective.

For the implementation phase of the design a lot of activities for trend and development implementation are needed. Most activities can be done in parallel to each other and can therefor be feasible on the mid-term. Only a supply chain wide track & trace system might need to be applied in a less mature stage to be finalized in a later stage. The main concern, about the implementation of the logistic design within this time span, is that all stakeholders in the chain need to change and invest a lot. The question is whether they are all ready and have the resources to change on this short term.

Evaluation of the design and conclusions

Most design requirements and constraints for the mid-term can be implemented in the future logistics design. Only robotization, 24/7 delivery and blockchain technology have not been (entirely) applied in the design, of which only 24/7 delivery has been set as a fixed requirement. This requirement is partly met with the more just in time delivery of the new design.

The objective ***to develop a feasible logistic design for the flower auction Royal FloraHolland for the year 2025, based on the maturity of technologies and trends in the floriculture market*** has been completed with the elaboration of the future floriculture logistics design. Testing the future logistics design to the trend analysis and requirements, the developed design might very well be feasible for the mid-term time span. Most important risk in the implementation of the final design before 2025 is that a lot of actions need to be taken for which much money and effort is needed from the various stakeholders. Stakeholders need to be aligned and all demands and benefits should be clear before the design can be implemented.

The flower auction house could earn a key role in the implementation of this design when it starts a target group that has conversations with all stakeholders. Questions about new roles in the market for each stakeholder, and demands and benefits should be asked. Only with respectful collaboration of stakeholders with high impact this design can be elaborated.

1 Introduction

This thesis is about the logistical vision of the floriculture market on the mid-term. To be able to get a proper understanding, this chapter first provides some background information about the floriculture market and the main operating partner Royal FloraHolland. After the background information the report outline will be presented.

1.1 Background information

One of the main Dutch export markets is the floricultural market. Floriculture or flower farming, is a business concerning ornamental plants and flowers. In the Netherlands itself floriculture is the 3rd export product at this moment, after gas and machines (CBS, 2017). In the future the export of gas will decrease since the availability will decrease as well. This could make floriculture the 2nd export product of the Netherlands. From Figure 5 it becomes even clearer what role the Netherlands has in the floriculture export. Here it is visible that the Netherlands are one of the main hubs in the floriculture sector in the world. the Netherlands have more than 40% of the market share in cut flowers (Rijswick, 2016).

Figure 5, Trade flows of flower bulbs, cut flowers, cut foliage and other living plants (excluding intra-EU) (Rijswick, 2016)

Since the demand for floriculture comes from all over the world, the floriculture market can be considered as worldwide. The key player in this floricultural market is the Dutch co-operative company Royal FloraHolland. Royal FloraHolland is the largest flower auction in the world and provides floriculture auctions and price formation, distribution and financial assurance. In the Netherlands Royal FloraHolland has the main role in this for executing both the logistical and informational activities. Since Royal FloraHolland is by far the largest flower auction house in the world, the company can be considered as market leader, knowing that smaller auction houses will only follow. Throughout this whole report flower auction house and Royal FloraHolland will be used trough each other.

Royal FloraHolland is a Dutch co-operative flower and plant auction, owned by the growers. Royal FloraHolland consists of 4 locations in the Netherlands, three export locations and one location for the domestic market. The three export locations are located in Aalsmeer, Naaldwijk and Rijnsburg.

The flower auction started in Aalsmeer in 1912 and fused in 2008 with the other locations to become FloraHolland (Redactie Oneindig Noord-Holland, 2010). After a few years the official name turned into *Koninklijke Coöperatieve Bloemenveiling Royal FloraHolland U.A.*, but the name that is commonly used is Royal FloraHolland. Royal FloraHolland is the largest auction house for plants and flowers in the world (Verdouw, Beulens, & Vorst, 2013).

An auction house is a market place where the price has not been formed when the product comes in. In an ordinary forward auction (with many bidders) (BusinessDictionary, n.d.) the product goes up for a bid. The price will start low and will be raised by the auctioneer after each bid. This will go on until the bidding stops and the product is sold to the one with the highest bid (Tedsvalleyauction, n.d.), also called: the English auction system.

Royal FloraHolland uses a different kind of auction system, almost the other way around than the renowned auction principles. In Royal FloraHolland the auction goes via an auction clock. This clock starts at a price higher than the market value and turns towards zero. When a buyer pushes the button the first, the product is sold to him at the price the clock shows. This clock system is founded in the Netherlands in 1887 (XtrActive B.V., n.d.) when a cauliflower grower started to sell his goods asking the highest imaginable price, going lower until anybody took his bid. This clock auction is called a Dutch auction and is still used in the food and floriculture auction. This auction system is suitable for many transactions in a short time.

Due to the growing e-trade market and online connections, the direct flows of floriculture are increasing, resulting in a risk for the flower auction to lose their value-adding activities. Royal FloraHolland has improved their value-adding activities a lot in the last few years with many new commercial concepts for sales in 2020 as result. Those concepts are called commercial transaction flows (Van der Vorst, Bloemhof & De Keizer, 2012). Every commercial transaction leads to a logistical command, which results in the distribution of transactions over the right trolleys.

In the floriculture market there is an important shift in flows: from the flows via auction houses to direct flows. From the beginning of the flower auction the flowers where brought together at the auction house, waiting to be sold and to be ready for distribution. In the last few years direct flows of floriculture are increasing, without the extensive distribution over the auction floor. Most of the times those direct flows consist of trolleys with only one or a few transactions on it. This leaves the trolleys with more transactions for the distribution on the auction distribution floor. The trolleys that enter the flower auction are becoming more and more physically fine-grained. A fine-grained trolley is a trolley with many transactions on it. The size of the transaction is clear after it is bought. This high volume of transactions puts more pressure on the distribution.

In 2010 a project has started in order the keep the Netherlands in the lead of the world regarding the floriculture market with innovative logistic concepts and collaborative business models. This project was called DaVinc^{3}i (Dutch Agricultural Virtualized International Network with Coordination, Consolidation, Collaboration, and Information Availability) (Vorst et al., 2012). The project is a collaboration between Dinalog Dutch Institute for Advanced Logistics, Productschap Tuinbouw, Wageningen University and Royal FloraHolland.

1.2 Outline report

This research is about trends and developments in the floriculture supply chain, with the goal to design a logistical model in which the flower auction house can operate.

The research will be performed in part A and the design will be elaborated in part B of this report. Afterwards some directions for implementation will be given. The report will be concluded with an evaluation and recommendations. Lastly, a reflection on the project is given. The entire outline of this report is given in **Fout! Verwijzingsbron niet gevonden.**.

Table 1, Report outline

Chapter	Number	Content	Pages
Introduction	Chapter 1	Introduction with background information	1-3
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2 Project outline

In this chapter will be clarified how the floriculture supply chain looks like and which key stakeholders operate in the supply chain. There will be elaborated on the flower auction as a key player in the chain. Their value propositions will be discussed as well as why it is needed to change parts of the supply chain. At the end the exact need of the client of this report will be discussed as well as the scope of this thesis.

2.1 Floriculture supply chain

The supply chain in floriculture starts at the growers of plants and flowers, both Dutch and international. Some growers will sell their products directly to the wholesaler or large retail chains, others will bring their goods to the auction house for distribution and price formation (Van der Vorst, Bloemhof & De Keizer, 2012). The main difference in this part is the direct pricing versus the clock price formation. After the wholesaler, products go to the retailer or will be traded international where they are sold in foreign markets. In the Netherlands, retailers sell goods to the final customer, the consumer. Other batches are sold from foreign growers to other foreign markets, in this case auction houses still play a key role in the price formation and communication processes.

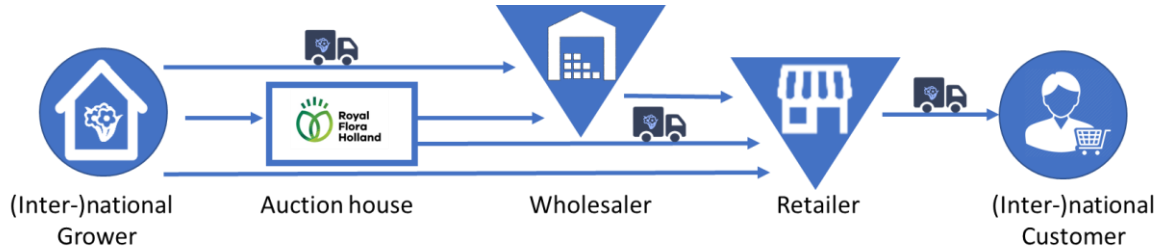


Figure 6, Supply chain floriculture

As visible in Figure 6, various flows of goods are possible in the floricultural supply chain. Some more direct flows and some step by step flows can be identified here. The key players in the supply chain are the growers and the customers, with the price forming in the auction house as important point in time. The final customers will have an important opinion about actions earlier in the supply chain. Those opinions will be ventilated by the retailer and wholesaler towards the auction houses and growers. This results in a demand from wholesalers to the auction house that is similar to the demands of consumers. Next to these core stakeholders in the chain, traders and third party logistic companies compute the supply chain (Verdouw, Beulens, & Vorst, 2013).

Trends are that flows are becoming more direct which could cause supply chain shortening (Clark & Busch, 2002). The last years this has been easier because of the online possibilities for faster connections. Large batches of plants and flowers are transported directly to wholesalers and large retailers. Effect of this is that the trolleys of plants and flowers that pass the auction houses are increasingly fine-grained. A full overview of all trends in the market will be described in chapter 3.

This thesis focusses on the activities in the floricultural supply chain with a special focus on the role of the largest floriculture auction house in the world: Royal FloraHolland (Verdouw et al., 2013).

2.2 Value propositions and logistic flow of the flower auction

Growers have a lot of influence in decision making of the co-operative flower auction. The value proposition of the flower auction has a few sides. One is the provision of an open market place with clock duty, another the certainty for the growers to receive their money within 24 hours although the transactions at the buyer's side are not arranged yet. Another value proposition is the certainty of

sales possibility for the grower. Every delivered product will be offered on the clock. Only products that are not sold will be destroyed. The last value proposition is the logistics and distribution process within Royal FloraHolland as largest flower auction in the world. In the future the value propositions need to be re-evaluated to be sure a flower auction can keep its right to exist.

The flower auction house also arranges standers for the entire market, which makes it easier to communicate through the market. Next to this the auction house provides logistic services to specific growers in countries outside Europe.

At this moment there is a vision towards the year 2020. The company vision for the long-term is starting to be formed. This vision should lead to a plan of change for the future. The focus will be on the whole floricultural supply chain with a focus on the auction house and the logistic activities within Royal FloraHolland. If Royal FloraHolland is watched from a distance within the floricultural supply chain, some incoming and outgoing flows can be recognized as shown in Figure 7, this is the logistic flow through the flower auction given in a IDEF0 functional model (Mayer & Dewitte, 1992). The inputs for the auction house are the products with information about their status and specifications. The outputs are the sold products and information about the transactions, where the main customers for Royal FloraHolland are wholesalers. This thesis focusses on the direct customers of the auction house, according to the supply chain chart this can be both wholesalers and retailers. The main logistic task at this moment is to bring flowers and plants from the incoming docks to the right customer exits. Those exits are at the client boxes from where the customers or third party logistic companies will transport the flowers and plants to the wholesaler or retailer. Another stream of flowers and plants, which is not shown in Figure 7, is distributed between parties that are no member of the auction house ("Buiten veiling om", BVO).

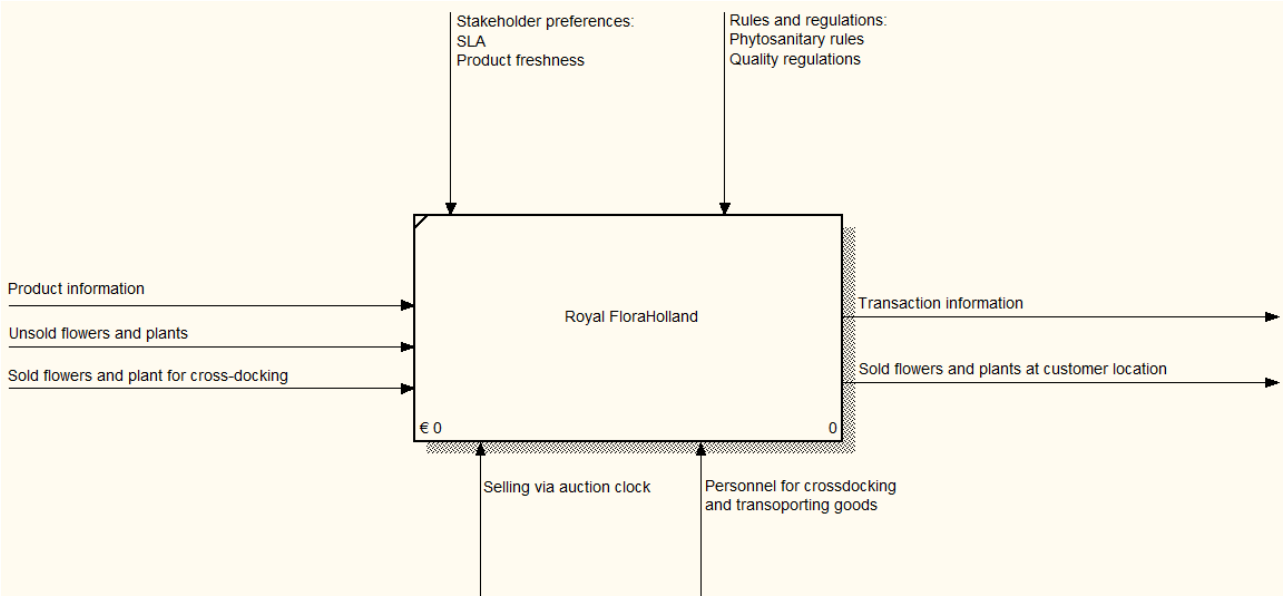


Figure 7, IDEF0 Logistic flow through Royal FloraHolland with incoming and outgoing streams

2.3 Need for change

At this moment the floriculture market needs to change. The market is still fairly complex. Some parts of the market are still conservative, where others are very modern. Many transactions are still running via a physical clock auction and are first shipped from various continents to the auction houses in the Netherlands to be distributed to other countries. This is very unstainable and many steps need to be taken to make the floriculture market more green. Since the market deals with

perishable products with critical throughput times and special handling methods, transportation of these goods needs special attention. With the long transport distances nowadays, the floriculture products perish very often, which brings in high costs of waste. It is still hard to shorten transport distances because many goods from various continents are first sent to a central hub in the Netherlands before they are transported to their final destination. Since products are not separately traceable it hard to change that manner. It is for example not yet achievable to attach a bar code to every separate packaging, because stickers will fall off because of the water in the buckets and other trackers are too expensive. This makes distribution more complex than in ordinary parcel distribution activities. Years ago, a physical market place was really needed to present the goods to show quality and set a price. Because of e-trade possibilities goods are transported more and more via direct flows causing supply chain shortening (Clark & Busch, 2002). Price can be set online and quality of goods can be shown on a virtual network. This online trend is also growing in the floriculture market. This change from physical local platforms (auction house) to worldwide virtual platforms has tremendous effects on the logistic operations.

In this time of internet, fast communication, online shopping and smart solutions, the market situation is able to change. When the floriculture market does not change towards a more efficient market in transport and information transmission, it will lose a lot of support from all over the world. The world's main flower auction Royal FloraHolland is a key player in this market, but should change rapidly to stay ahead of competition. Smaller companies are faster to adopt new solutions like web based technologies and platforms which could become substitutes for the activities of the auction house. This can cause high pressure from competitors towards the flower auction to change rapidly. This is why large steps for rapid change are required for Royal FloraHolland.

Floriculture is a luxury product. Since the economy is growing after the economic crisis and the welfare in the world is growing, the product is expected to become increasingly popular. Flight movements are increasing and transport channels are improving which makes it easier to create direct flows and to shorten the supply chain.

Next to this there is an important shift in many supply chains towards a more demand-driven supply chain. At this moment the whole floricultural sector depends on the clock times, which creates peak processes throughout the whole supply chain. A demand-driven supply chain requires a change in the auction concept towards a more 24/7 way of working. This becomes more and more possible because of the growing digital environment that companies are working in.

The combination of changes in the floriculture market enable a perfect timing to make radical changes in the logistic flow within the floriculture market. The logistic operations in and around the flower auction will be an important part of those changes.

In earlier research from the TU Delft (Stubbé, 2016) the current situation of Royal FloraHolland in the year 2016 has been described. This 2016 situation is taken as the baseline for this thesis.

2.4 Client's need

The problem owner in this case is Royal FloraHolland. From now on Royal FloraHolland will be considered as the client for this thesis.

As described above the client Royal FloraHolland needs to change its activities to keep its existence in the floricultural supply chain. The current logistic flow needs to change to a more profitable and efficient flow on the mid- and long-term. In the floriculture market it is not common to create long-term strategies for more than 5 or 10 years. The currently running strategy, composed in 2014, is created for the year 2020 and visible in Figure 8. There is no clear mid-term or long-term vision for

the flower auction house existing at this moment. A coherent future vision and a fitting logistic flow is needed to get to a feasible logistic plan for Royal FloraHolland for the medium term.

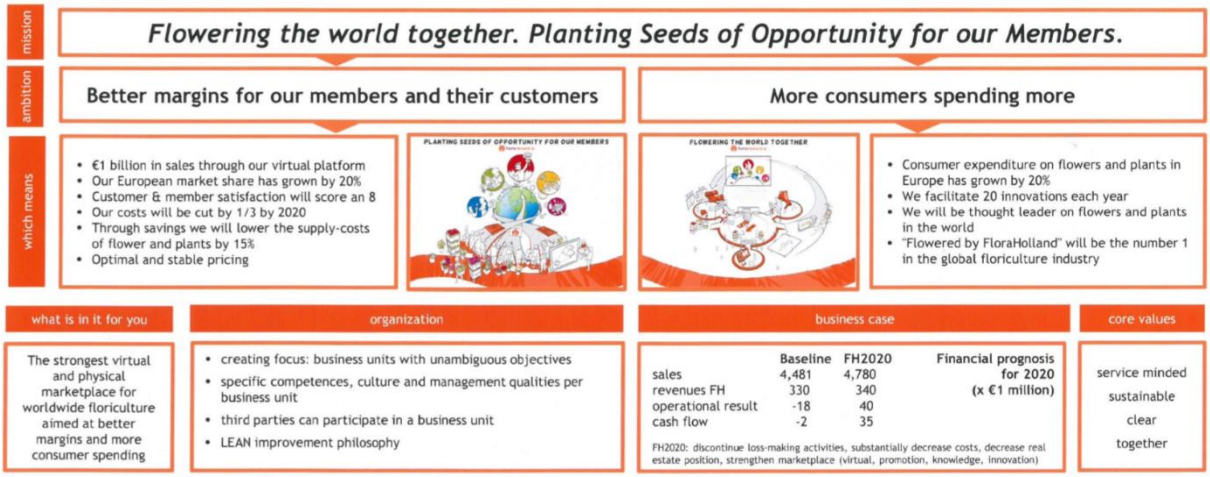


Figure 8, Royal FloraHolland 2020 strategy (Stubbé, 2016)

In order to get to this mid-term logistic flow, a vision for the long term is needed. For the long term the year 2030 has been chosen. The year 2030 is chosen as the furthest point in time for which a realistic view can be created especially in this market. Since it is unrealistic to design a logistic flow for a point in time so far in the future, it's important to interpolate towards a more feasible mid-term situation, see Figure 9. This mid-term situation has a time span between 5 and 10 years from now, so between 2022 and 2027. For the communication throughout this project the year 2025 is used. The 2030 situation will be the dream situation in which all systems and algorithms are implemented and running. The 2025 situation represents a situation in which most physical implementations could be finished, but still optimizations can be applied. It is important to sketch the physical, informational and part of the commercial ideas for the future logistics within the floricultural supply chain to find the optimal 2025 situation.

Between the situation now, 2017, and this situation in 2025 many steps have to be taken. Trends and developments in the market will affect this time lapse. Specific changes within the supply chain will get visible forms in about five years from now. A market is always changing, but this specific market needs to change in the next years to keep up with competitors like online web shops.

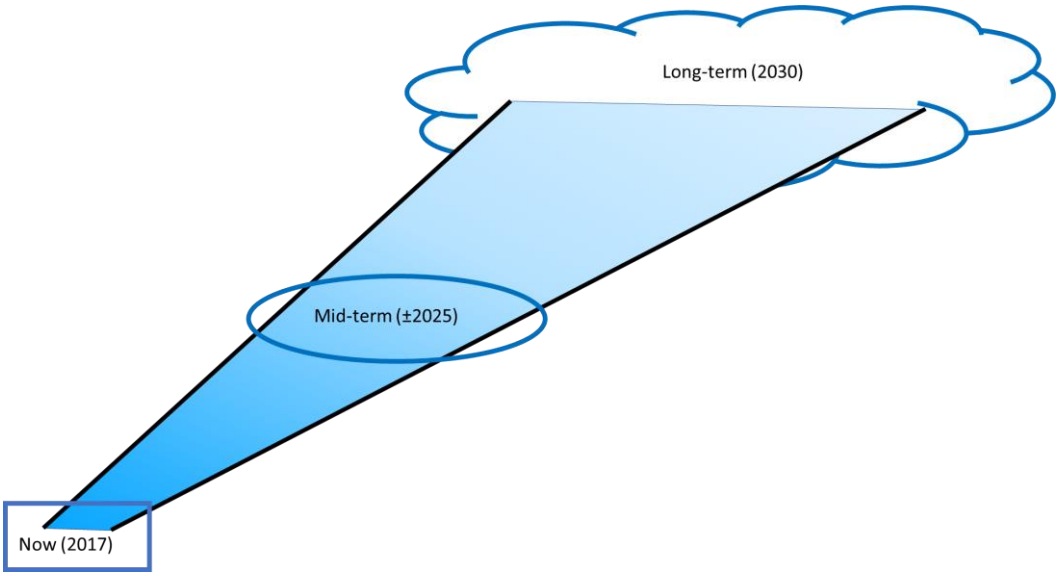


Figure 9, Interpolating towards 2025

Since changes are often developed in a commercial environment, the effects on the logistics are unclear. The long-term vision includes all technologies that we know of, where the mid-term vision only includes technologies and changes that can be realized before this date. After these views on 2030 and 2025 are clear, a redesign should be made for the logistics and information flows containing the innovative techniques and knowledge of 2025 taking into account the direction for 2030. From this midterm vision needs to be interpolated to an even earlier moment to find the right implementation steps.

The main client's need that follows from this problem is to design a logistic concept that incorporates all incoming streams at the flower auction. This design needs to be developed from scratch, with the situation and the wish for the future as input. It allows the design for using new and innovative solutions. The new system should be developed in a way the customer requirements can be fulfilled. Next to this it should lead to a concept that allows Royal FloraHolland to still exist in 2025.

2.5 Project scope

For this project the first part of the floriculture supply chain is take as the scope. This first part is from the growers of the flowers and plants until the buyers of the flower auction house, see Figure 10. Since it is not reasonable to assume that retailers and wholesalers will cease to exist in 2025, they will be considered as the main customers for the auction house, since consumers cannot buy from the auction house directly. This means that the retail strategies and applications towards end consumer are out of scope for this thesis. It is assumed that consumers and smaller retailers who are not buying at the flower auction house, will ventilate their wishes and demands via the wholesalers and retailers to the flower auction house. Retailers can buy products directly from growers are via the flower auction house or even from the wholesaler. They will sell to various consumers. In this project only the flows going through the flower auction house or directly from the growers to wholesalers or retailers are in scope.

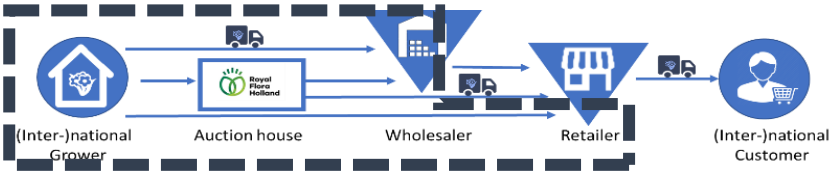


Figure 10, Scope within supply chain

Other constraints for this design are that the design needs to be feasible on the medium term, so before 2025. This means that only existing trends and technologies with a high maturity level on the mid-term can be incorporated in the final design.

The new logistics design will not start from the original situation in the floriculture chain and at Royal FloraHolland, but start with the needs of all stakeholders for the complete supply chain. This could cause a shift of position in the supply chain for the largest flower auction house in the world. Only the parts that cannot be changed, or are too expensive to be changed, before 2025 will be considered as a given fact. This is the reason why the three main locations of Royal FloraHolland will be considered as a given fact. However, the role of the locations can change over the years.

This thesis will focus on the supply chain part of the organization. Commercial processes will have their consequences in the logistical processes. This thesis will disregard commercial operations and start from the commercial demand towards the logistic operation. A commercial platform will give orders to logistics, which will be the starting point for this thesis.

In case of Royal FloraHolland the most important logistical question is how the flowers will go from the growers, which can be considered as the producers in the supply chain, to the right buyers. Price

formation and commercial interventions will be out of scope for this project. Next to this a future proof IT system and warehouse management system are a boundary condition for this project and will therefore not be discussed throughout this thesis.

2.6 Problem statement

In the last few years the demand of customers to change current logistics in the floriculture supply chain has increased. Customers, the buyers at the flower auction house, want their bought products to be delivered at demanded times. Since many products are exported to other countries by airfreight transport, those products need to be on the airport at a certain time. When they do not make it in time for their flight, the perishable product needs to wait until another flight the next day. Current logistics within the floriculture supply chain is not arranged for the demanded business model of the customers. A set of new commercial transaction flows has been developed by Royal FloraHolland to meet those demand changes, see Appendix A3. This change towards the new customer demand leads to different problems in the logistics at the auction house. The commercial system of clock auctioning is still based on one selling moment a day, which puts a lot of pressure on logistics. To change to the new business model, all stakeholders need to be convinced by a different selling mechanism. This will also have large impact on operations.

In this thesis the trend of this changing customer demand and many more trends will be analyzed to find improvements for the logistic flow on the mid-term within the floricultural supply chain. This will come together in a design to meet the next objective:

To develop a feasible logistic design for the flower auction Royal FloraHolland for the year 2025, based on the maturity of technologies and trends in the floriculture market.

Now the client's need has been discussed and the problem statement is clear, the methodology for this engineering design can be presented. First the client's need will be rephrased in a problem definition and some objectives will be discussed. Subsequently the further planning will be discussed.

2.7 Methodology

A redesign of the current logistic operation of the flower auction in the 2025 situation is needed. First research will be performed to find a feasible redesign. This research will be built up in two parts: A and B. Part A will be a literature study and will consist of stakeholder consultations in order to collect all inputs that are needed for a good design. Requirements and objectives for the design will follow from part A. Part B will consist of a conceptual and a more functional design.

From the problem statement it is clear that the need of the client requires a new logistic design. From an academic perspective the most fitting methodology for this thesis would be one of engineering of a new system. Many design methodologies can be used to fulfill this. For example, the Dym & Little model (Dym & Little, 2000) is a ten-step model in which the objectives, requirements, constraints and functions form the problem definition for the generation of a final design. Another method would be the Basic Design Cycle (Roozeboom & Eekels, 1995) in which the function of the new system will be basis for analysis for the new design. For this design process the Dym and Little model will be used as a basis since the steps in this method are smaller than the Basic Design Cycle and will make it easier to set a final goal before the end of the cycle. The Dym and Little model will be changed at some points to fit the project. This model starts with a client statement from which the problem definition follows, see Figure 11.

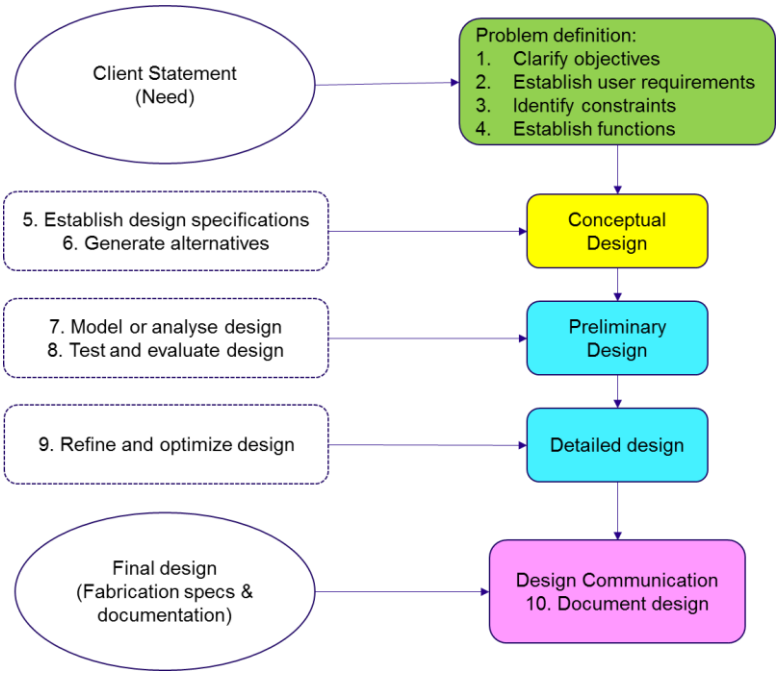


Figure 11, Design process (Dym & Little, 1999)

In this figure the methodology of Dym and Little is presented. First it is important to understand this methodology to work towards a methodology that fits this thesis best. In the first part of this methodology the client statement will be elaborated concerning the objectives, requirements, constraints and functions. When the exact client's need is clear a conceptual design can be started followed by a more detailed preliminary design, finishing with a detailed design. When the design is finished it can be evaluated and communicated. This methodology of Dym and Little is the basis for the methodology that will be used throughout this thesis. Where required it will be changed to fit the purpose of this report.

Figure 11 shows the design process that can be divided in roughly four phases:

1. Preparation phase (green): in this phase the designer needs to phrase the field in which he can design.
2. Generation phase (yellow): a phase in which the problem is defined and some concepts are designed (Dym & Little, 1999).
3. Evaluation phase (blue): Chosen design is tested in this phase against the client's objectives and against specifications for the functions of the system.
4. Communication phase (pink): in this last phase the final design is communicated to the client.

This thesis will be split up in two parts: A and B. Phase A will be more focused on research and B on design. Phase number one, the preparation phase, will be developed in part A. This will lead to the requirements for number 2. The generation phase will be discussed in part B together with a part of the evaluation phase. This will be concluded with the communication phase. This division is show in Figure 12.

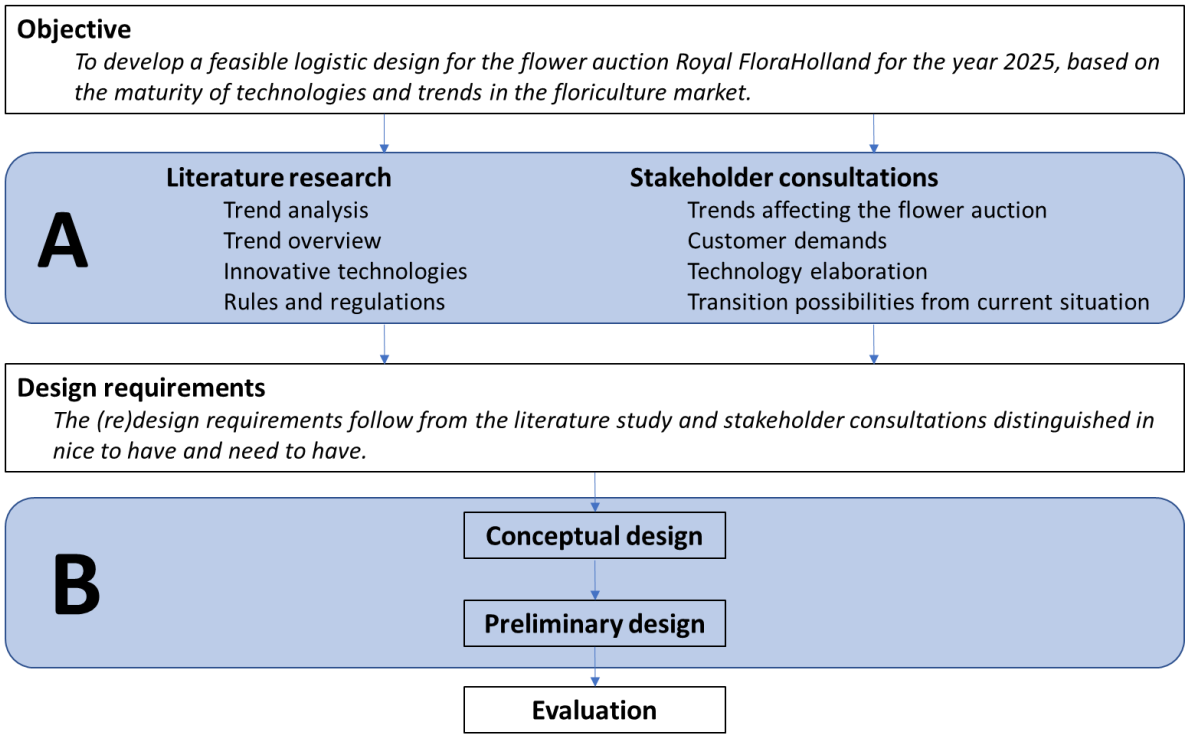


Figure 12, Methodology based on model of Dym and Little

Comparing this methodology for the thesis with the methodology from Dym and Little, Part A can be recognized in the green part of the client statement. Point 5, Figure 11, from this methodology, formulating the design specifications, will be the connection between part A and B. The yellow and blue part, conceptual and preliminary design will be elaborated in part B. The detailed design will not be presented in this report. The preliminary design will be the final design of this report and will be called the future logistics design. The final pink part will come up during the evaluation when the transition proposal will be discussed.

2.7.1 Part A

The main objective for the research project is ***to develop a feasible logistic design for the flower auction Royal FloraHolland for the year 2025, based on the maturity of technologies and trends in the floriculture market.***

The research question in this case is: If Royal FloraHolland could redesign the logistic flow of the flower auction, what would a feasible logistic flow for the flower auction Royal FloraHolland for the mid-term time span, in the year 2025, based on the maturity of technologies and trends in the floriculture market, look like?

For the research in part A the research question has been split up in sub-questions that need to be answered to get the right input for part B. The analysis of those questions will be done in part A and the elaboration of the answers to the questions become visible in part B.

Sub-questions that need to be answered in this part are:

Q1) What trends and innovations can be recognized to play an important role in the floriculture supply chain until 2030?
   a. Which trends and developments are already visible in the floriculture supply chain?
   b. Which innovative technologies in logistics and ICT can be recognized in other markets to improve to future situation of the floriculture chain?

Q2) How can trends and innovations be combined to formulate a mid-term solution direction for logistics?
Q3) What are the requirements for the redesign?

For the first question a trend and development analysis is needed. This analysis will show what trends are ongoing and will reach market maturity before 2025. Trends in other markets need to be included in the trend analysis. For the sorting of the trends found, they will be mapped on the Gartner hype cycle to find more information about market maturity. Next to this a relationship analysis will be done to combine trends and developments to compose a feasible design for the mid-term. A model based on the morphological model of F. Zwicky (Zwicky & Wilson, 1967) will be used to display the parameters and trends for the various years (Ritchey, 2013). This will support the answer of the second research question.

With the answers to these questions a set of requirements can be composed that will be the input for part B, the design. Requirements for this design will come from a combination of the answers to those questions within the scope that has already been set earlier. Those requirements will form the boundaries for design. Within those boundaries a blueprint for the new design can be created. If the boundaries are clear the design aspects need to be determined.

When the requirements are determined they need to be validated by the management of Royal FloraHolland before the design can be made. When the requirements are fixed, they are expected to be of sufficient level for the design to be drawn.

The conclusion of part A will be the finalization of the preparation phase. In this phase the problem will be defined and objectives, requirements, constraints and functions for the new design will be given.

2.7.2 Part B

In part B the generation phase starts. Research has been completed in part A and part B will be used to make a conceptual design and a future logistics design.

Conceptual design

To make a conceptual design the next question needs to be answered:

Q4) What will a conceptual design for the flower auction in the 2025 situation of the floricultural supply chain look like, using the solution directions found in part A?

This question will lead to a conceptual model of the solution directions combined with the requirements for the mid-term situation. This will be displayed from the view of the whole floricultural supply chain and will show what the role of a flower auction can be in a conceptual way. A combination of trends that are feasible on the mid-term will be used to make design choices. In this design, market trends and innovations as well as customer demands will be taken into account.

Future logistics design

After the conceptual function of the flower auction in 2025 has been drawn, an in-depth analysis of logistical solutions can be started for the processing of incoming flows fitting the constraints and meeting the set of requirements from the research sub-questions.

To make the future logistics design, the next question needs to be answered:
Q5) How can the chosen solution directions be combined into a final design and how to migrate from the current situation towards the designed situation?

a. How can the solution directions be combined into a final design?

b. What are the effects of the design to the key stakeholders in the chain?
c. How does the final design meet the given requirements?
d. What are the differences and similarities between the current situation and the operation in 2025 and what implementation steps are needed?

This future logistics design will be a derivative of the conceptual design and will be given in a flowchart similar to the one in appendix A3 Actions of Royal FloraHolland to achieve 2020 vision requirements. In this flowchart the logistical stream and the most important information messages will be drawn.

2.8 Final deliverables

First a conceptual design will be drawn from the mid-term vision of the supply chain. The final deliverable for this thesis will be a future logistics design. This future logistics design is an elaboration from the conceptual design. The future logistics design will first be explained with some clear pictures of the most important parts of the design. Thereafter, the design will be concluded in a flowchart.

Following the methodology, the evaluation and communication phase need to follow. For this, the effects of the design on all key stakeholders will be explained. Next to this some directions will be given towards an implementation of this final design into the floriculture market. The research will be concluded with an evaluation of the design by concluding the main objective of this report. Thereafter in a discussion and recommendations will elaborated on the steps taken during the research.

Part A

Literature research and stakeholder interviews will be combined to configure a vision on the long-term logistical situation of the floriculture supply chain. A relationship and maturity analysis is performed to find solution directions for the mid-term situation of the floriculture market and the position of the auction house in the supply chain. From the possible solutions, the most fitting ones will be chosen. Requirements are determined for the logistical design of the operations of Royal FloraHolland on the mid-term. The design will be elaborated in part B.

Chapter 3 will start with some notable cases in the floriculture supply chain. In paragraph 3.2 trends and developments from both inside and outside the floriculture market are described. In this paragraph the first research question will be answered:

Q1) What trends and innovations can be recognized to play an important role in the floriculture supply chain until 2030?

a. *Which trends and developments are already visible in the floriculture supply chain?*
b. *Which innovative technologies in logistics and ICT can be recognized in other markets to improve to future situation of the floriculture chain?*

From paragraph 3.3 until paragraph 3.5 the trends found in Q1 are further analyzed. This analysis will be concluded with a combination of trends to find possibilities for the mid-term design. The conclusion of paragraph 3.5 forms the answer to the second research question:

Q2) How can trends and innovations be combined to formulate a mid-term solution direction for logistics?

In chapter 4 the requirements for the mid-term logistical design are discussed. These will answer Q3:

Q3) What are the requirements for the redesign?

3 Trend and development analysis

In order to get a good view on the 2030 situation a trend and development analysis will be performed. The year 2030 will be used as a direction for the mid-term vision for the year 2025, this year has been chosen as an indication. 2025 Is chosen since it represents the first main step after the current 2020 vision of Royal FloraHolland. This analysis is performed by interviewing experts in the floriculture chain and in technology and by literature research. The interviews are summarized in Appendix A1. The scope for this trend analysis is the whole floriculture supply chain until the buyers from the flower auction, so the wholesalers and retailers, see Figure 10, Scope within supply chain, paragraph 2.5. The consumers and smaller retailers are out of scope for this analysis. Assumed is that their demands are represented by the demands of the auctions' buyers.

In order to find logistic solution directions for the mid-term situation, some steps need to be taken. First notable cases in the current floriculture market are described. Subsequently the trends and developments relevant for improvement of the market until 2030 are investigated. This is split up in two parts, one for the trends within the floriculture market and one for trends in other markets that could be applied to the floriculture market. When all trends and developments are described and summarized, an overviewing long-term vision towards 2030 can be given. This will be done in paragraph 3.3. The Gartner hype cycle will be used to create a better overview of each trend with respect to market maturity and expected entrance in the floriculture market. This analysis will result in a morphological model, to determine which trends will be feasible on the mid-term. Using this morphological model, future solution directions can be found. Those will further be described in paragraph 3.6. The visual overview of this chapter with all paragraphs is given below in Figure 13.

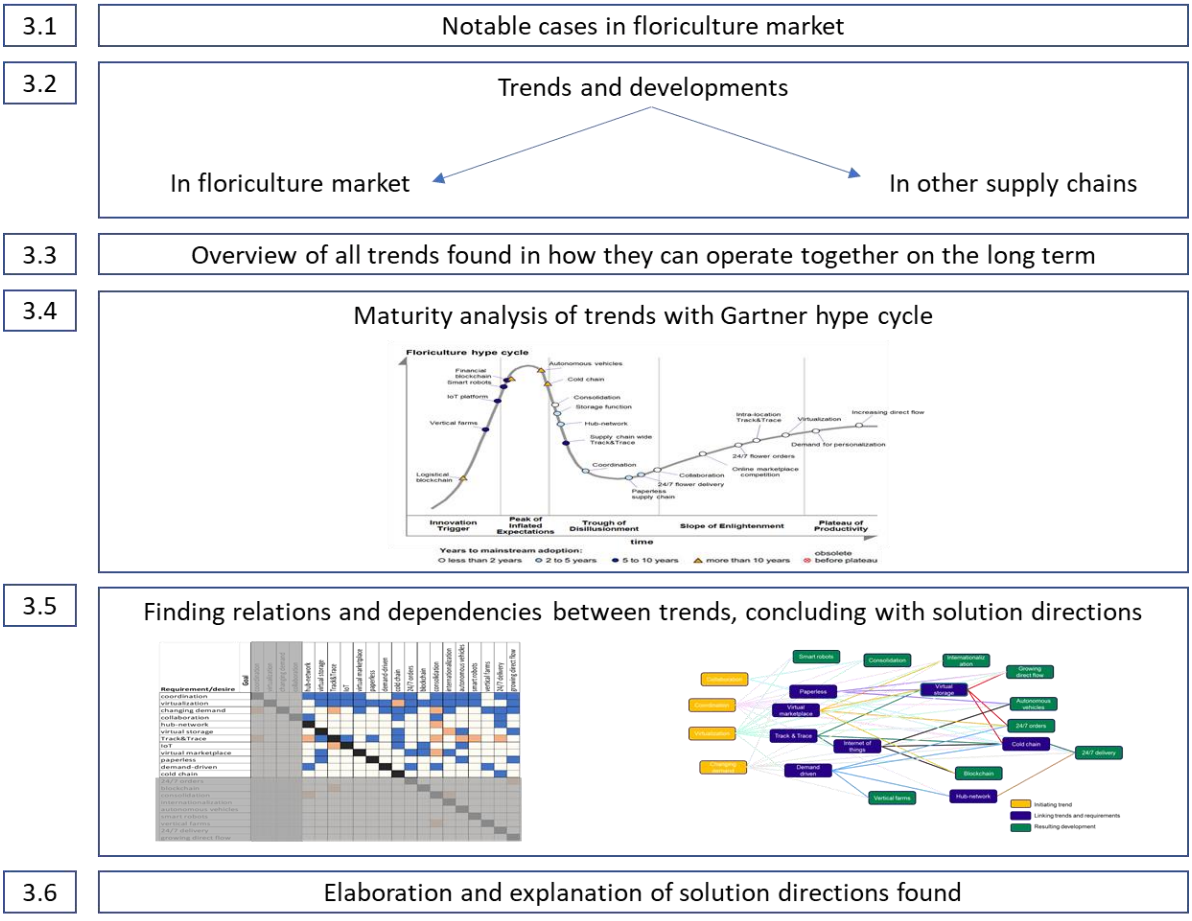


Figure 13, Visual overview chapter 3

3.1 Notable cases in floriculture market

In the floriculture chain many growers are located close to each other on specific places. In the Netherlands the auction houses have originated close to those locations. The auction houses merged some years ago into one auction house Royal FloraHolland. The locations Naaldwijk, Rijnsburg and Aalsmeer can be seen as naturally originated hubs in growers' areas. In the earlier times those hubs were used by the growers to trade at the nearest location. Those hubs happen to be close to large main ports serving for transport, Naaldwijk is located close to the harbour of Rotterdam and Aalsmeer is located close to Amsterdam airport. Nowadays growers are increasingly considering wider sales markets to transport their products to, instead of only the closest location, to bring their products.

Another notable case in the floriculture market is that some parts of the market are still very conservative, where other parts and stakeholders are incredibly modern. Products in the floriculture chain, for example, are handled with a unique identification code instead of the standard bar code. The use of technology in the floriculture market depends per stakeholder. In some parts of the auction trolleys are still literarily pushed under the clock to show which product is for sale.

A last notable case is about rules and regulations. In order to transport flowers and plants outside the EU a phytosanitary transportation document is needed issued by the Netherlands Food and Consumer Product Safety Authority (NVWA, 2017). This to secure rules and regulations around the transportation. Checks are performed randomly to make sure the goods meet all import requirements.

3.2 Trends and developments in the market

Now the notable cases of the current situation are clear, the trends and developments for the future floriculture market are analysed. After this analysis sub-question Q1 can be answered. This sub-question is split up in part a and b. Part a will be answered in paragraph 3.2.1 and part b will be elaborated in part 3.2.2.

Q1) What trends and innovations can be recognized to play an important role in the floriculture supply chain until 2030?
   a. Which trends and developments are already visible in the floriculture supply chain?
   b. Which innovative technologies in logistics and ICT can be recognized in other markets to improve to future situation of the floriculture chain?

First trends will be discussed that are already used in the floriculture chain and have much to do with the demands of growers and customers. In the second part of paragraph 3.2 trends and technologies are discussed that are either applied in other supply chains or which are not yet available on the market. The expectation of those developments is that they could be adopted in the floriculture chain in the future, but due to the complexity of the market it is hard to expect the timing of introduction of those technologies in the floriculture market. At the end of the paragraph the described trends will be concluded in one overviewing market sketch. All trends that will be described throughout paragraph 3.2 and their sources are given in Figure 14.

DaVinc^{3}i: Consolidation Collaboration Coordination Virtualization	**Royal FloraHolland:** Virtual storage Autonomous vehicles 24/7 delivery Virtual marketplace Paperless More demand driven More direct flow
Interviews: Hub-network Track & Trace Changing demand 24/7 orders Internationalization	**New technologies (other markets):** Vertical farms Internet of Things Cold chain Blockchain Smart Robots

Figure 14, Origin of trends in floriculture chain

3.2.1 Trends existing in the floriculture supply chain, from buyer and grower demands

Trends that will be analysed in this paragraph are derived from important research in the floriculture logistics market like DaVinc^{3}i and from projects running in Royal FloraHolland. These trends are virtualization, collaboration, consolidation and collaboration (Ossevoort, Vorst, Verdouw, & Wenink, 2012). In order to make the logistics more efficient, and to make use of consolidation, increased utilization of hub-networks based on the physical internet is desired. Next to these trends, interviews and conversations with Royal FloraHolland employees led to various topics that are important trends within the floriculture chain. Those trends are a more international market, increasing direct flow (FloraHolland, 2017b)(Wierik, Wenink, & Wiersinga, 2017) instead of selling via the auction clock and change in customer demand (Van der Vorst, Bloemhof & De Keizer, 2012) and the change of consumer type. This change in customer demand leads to a more pull, demand-driven supply chain and 24/7 market operation with a storage function in the supply chain. Another important trend at this moment of increasing digitization is the upcoming competition for the flower auction by e-tail companies, offering and selling product via internet.

In the DaVinc^{3}i project research is done for improvement in consolidation, collaboration and coordination in the floricultural sector. Those developments are used to keep the Netherlands in the lead in this industry (Ossevoort et al., 2012). Those trends can grow faster because the world becomes more digital. The speed and use of internet is increasing the last years, which enables various opportunities via informational improvements. Those informational changes enable physical supply chain improvements as more efficient transportation. Virtualization at the one hand and changing customer behavior at the other hand are the most important trends in the market that enable the other discussed trends.

Virtualization

DaVinc^{3}i was set up to develop innovative logistic concepts for a more virtualized market. Starting points for the project were an information platform like Digital GreenHouse, developed by Royal FloraHolland and more collaborative business models (Ossevoort, Keizer, Vorst, & Wenink, 2014). Virtualization forms a basis for coordination, collaboration and consolidation. With the increasing amount of digital possibilities, communication and transportation connections within and around the supply chain are becoming shorter. Virtual platforms for both price setting and logistic services can support a more efficient way of transportation. At this moment KOA ('kopen op afstand – buying on distance') is a possibility to buy flowers and plants at the auction house from a different location with

virtual auction clocks. From an interview with the digital strategy manager of Royal FloraHolland (Wilting, Manager Digital Strategy, May 3, 2017) it became clear that the whole floriculture trade will be virtualized in the near future. He foresees a digital trade platform for the commercial and financial handling operated by the auction house. On this platform logistical services can be offered for specific prices. With this platform Royal FloraHolland stays key stakeholder in the floriculture supply chain, as the only stakeholder with all the knowledge of growers and buyers. According to Wilting logistics could be disconnected from Royal FloraHolland, but this is not necessary.

Virtualization throughout this thesis is used to describe the upcoming virtual platforms and as support for a more worldwide market with traceable products.

Collaboration between stakeholders

Since the introduction of the internet, connections between people and companies all over the world have become faster and easier. Collaboration between parties in the supply chain, both horizontal as vertical, has increased because of those easier connections. This has resulted in the trend of chain shortening (Clark & Busch, 2002) applied on the floriculture supply chain. This supply chain shortening makes it hard for smaller parties to keep the same market value, since larger companies are most of the times better arranged to take up more parts of the supply chain at the same time. This asks for collaboration or even fusions between smaller growers and other parties in the chain. Supply chain collaboration can happen on various levels, information and resource sharing are very important, however, one can also think of joint knowledge creation or collaborative communication (Cao et al., 2010). In floriculture market there is a lot of information sharing already, however, companies can make more profit with collaborative advantage (Cao & Zhang, 2011). Numbers from Royal FloraHolland show that the number of suppliers (growers) decreases every year, where the total volume passing the auction floor increases (RoyalFloraHolland, 2016). Such collaboration could create a potential maximum value for all collaborating parties (Daugherty et al., 2006). When this collaboration is formalized a strategic collaboration can be achieved. Strategic collaboration has the goal to create a transparent supply chain with a visible demand pattern which paces the product flow through the whole chain (Holweg, Disney, Holmstro, & Sma, 2005). By collaborating with other growers, it is obvious that product flows through the supply chain can be consolidated. Consolidation can lead to a reduction in cost, time and emissions throughout the whole supply chain (Vorst et al., 2016).

Consolidation

In Europe one fifth of all trucks is driving completely empty and from all loaded trucks, 30% of the trucks is not completely filled up (Zeemeijer, 2016). This is an enormous waste of movements. Virtual supply chains with smart algorithms could help to reduce this waste. Those algorithms should calculate the most efficient way of consolidation in the whole chain, or even combined with other chains, to come up with a more sustainable transportation network.

Consolidation can happen on three levels in logistics: inventory, vehicle and terminal consolidation (Hall, 1987). It is called consolidation when different items are brought together and travel in the same load. When items share the same origin or destination consolidation can be an interesting option. Inventory consolidation is the name for storing the load of items until the shipment is large enough to reduce costs. Vehicle consolidation is a form of combining loads from different suppliers in one vehicle and dropping them off at their final destination. In the last form of consolidation, terminal consolidation, goods from various origins are brought to one single location from where trucks can leave for their final destination. This saves a lot of truck kilometres from the situation of every truck driving separately from the origin to its final destination.

The described forms of consolidation and especially the terminal consolidation asks for Urban Consolidation Centers (UCCs) (Browne et al., 2005). Those centers are meant for bundling loads to

avoid vehicles to carry part loads into busy areas, which can tremendously decrease traffic congestions. Those UCCs can serve as hub-functions.

Consolidation of flows could result in less truck movements, which makes the supply chain more sustainable. Smart algorithms could help stakeholders in the chain to consolidate flows in an optimal way. This could result in important steps towards a more effective supply chain.

Hub-network (based on physical internet)

The hub-function has often been discussed in literature. In DaVinc^{3}i a hub-network in the floriculture logistics has been researched (Ossevoort et al., 2014). A study combined with Wageningen University and Royal FloraHolland resulted in the idea for HubWays (Veen & Vorst, 2011). HubWays shows that because of digitization in the last years, many more movements of floriculture goods through the supply chain have been introduced. Since it is now possible to buy products virtually (at location or from distance by displaying only a picture instead of the real product), products have to be shipped towards the location of the buyer, not being at the location of the auction house. This while the same flowers and plants could come from a grower close by the customer location. HubWays is subsidized by the Dutch government and tries to reduce the amount of movements by introducing coordination between growers, carriers, buyers and the auction house. From a conversation with the manager of one of the strategic projects within Royal FloraHolland (Wiersinga, Program manager Flow, April 24, 2017), a hub-function for the flower auction house has been discussed and will be tested in countries as China in the near future. This hub-function was called central warehousing, in which Royal FloraHolland could play a key role in the warehousing concept.

The hub-network can serve a more efficient way of transportation. In this way floriculture can get from the grower to the consumer in the most efficient way, with less movements than currently needed. In Figure 15 an example is given for how hubs can make logistics in France more efficient and sustainable (Ballot, Montreuil, & Thivierge, 2012).

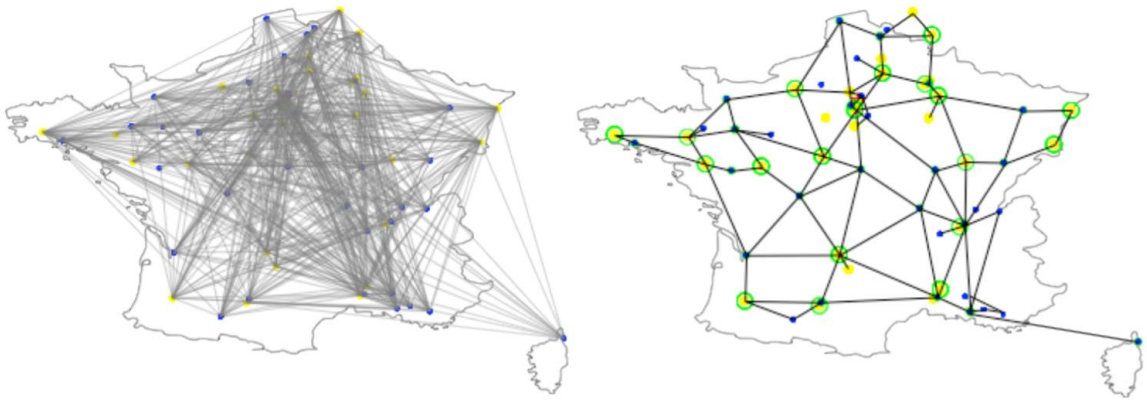


Figure 15, Original situation and schematic view of impact of hubs (Ballot et al., 2012)

The hub-function can be developed into a hub-network for the floriculture chain. In this hub-network many locations will be used to fulfil break-bulk and storage functions. The current locations of Royal FloraHolland already fulfil this role partly. This hub-network is inspired by the physical internet (Montreuil, 2011). The physical internet is a hub-network with hubs on many places all over the world with the goal to reduce inefficiencies and kill unsustainable symptoms in transport. Important parts of the vision of the physical internet is to set a standard for smart containers and cubing systems and a universal multi-segment inter-modal transport network. Products should be materialized in a way they can efficiently be transported and close to the point of use. This all should achieve global logistic sustainability.

For the floricultural chain the scope is smaller than for the physical internet. By setting a standard for trolleys and buckets, etc. and using hubs for transportation, the logistics in the chain can be improved. However, optimizing logistics in the floriculture chain is harder than in other markets. Since every product from every grower at various times has a different value, it is hard to predict which product needs to go to what place. A 30cm red rose from grower A at date X has a different value than a 30cm red rose (seemingly the same product) from grower B at the same date, so this product is demanded by another buyer in possibly another country. A hub-network will still be possible, but sending goods on prediction will be hard in this market.

Coordination
Collaboration and consolidation cannot be achieved without coordination. Hubs or trade parks are fulfilling this coordinating role by linking local and global flows. With this coordination the logistic network can be improved and flows can be consolidated more easily (Vorst et al., 2016). By interorganizational coordination the information sharing and transportation of goods within the supply chain, can be improved (Vorst et al., 2012). Logistics within a supply chain can be synchronized between interrelated stakeholders in the chain. This could help to optimize the fulfillment of customer needs.

Internationalization
Because of virtualization possibilities and the growing amount of (air)traffic movements, the floriculture supply chain is increasingly internationalizing. Large floriculture suppliers are growing their goods in countries around the equator like Kenya, Ethiopia and Ecuador. In Kenya it is even one of the most crucial sectors in economy (Kangogo, Guyo, Bowen, & Ragui, 2013).
At this moment many flowers are transported from countries in Africa and the Americas to the Netherlands to be sold by the auction. From the Netherlands they are transported again towards the final customer either in the Netherlands or abroad. Because of this devious transportation network and with the support of virtualization, an increasing amount of flows is transported directly to the final customer.

More direct flow
Because of the internationalization of growers and customers it makes less sense to send all floricultural goods first to the flower auction house in the Netherlands before it is transported to other countries. In the last few years the direct flow of flowers and plants is growing while the clock flow is decreasing (Wierik et al., 2017). In 2016 the shift towards direct sales from grower to customer was 1,9% higher than in 2015. In 2016 the total clock sales were 45,8% of the total revenue and the other 54,2% of the revenue came in via direct sales (FloraHolland, 2017b). Growers first try to sell their goods for a good price directly to the buyer. Goods that are not sold via direct flow, will be brought into the clock flow.

Most of the directly sold products are large batches of products bought by large customers, however, large customers also buy increasingly fine-grained transactions. This results in smaller batches and smaller customers buying and selling via the clock. This pattern causes smaller transactions and customer trolleys being increasingly fine-grained. Because of this, the handling time for the break-bulk function of Royal FloraHolland increases which puts more pressure on the logistics department.

The direct flow is expected to increase in the coming years. This is an important trend to take into account before any drastic decisions are made for changing the floriculture chain logistics.

Changes of consumer behavior
Consumer behavior is always changing. Trends as urbanization, individualization, digitization and wish for convenience are changing supply chains (Ven, Manager communications Let it Grow, May

19, 2017). Consumers will have smaller houses without gardens in the cities, this asks for different types of flowers and plants and other delivery patterns. Startups with subscription services like Bloomon, a company who delivers flowers every certain amount of time at a regular fee, are growing since they can act on customer's needs like service and products on demand. The floriculture supply chain needs to change towards a more demand driven chain compared to the situation at this moment. Consumers increasingly determine what happens in the chain (Wiersinga, Program manager Flow, April 24, 2017). With the possibility of online selling and buying, customers get in charge of when they want to order and receive the products.

From push to pull, demand-driven and flexible

At this moment the products that are sold via the clock principle are distributed towards the customer area, after the sales moment. The trolleys are transported from the cooled storage area towards the distribution area in the order of sales. Then the split of flowers and plants towards the right customer trolley will start. This is very much a push process in which the supply is an important factor in pricing. Looking at the customer order decoupling point of the floriculture market, it is very much a push process. The distribution of transactions towards the right customer can start when a trolley arrives in the right buffer in the distribution area. This distribution is a breakbulk function done in reversed picking. Looking at the customer order decoupling point (Hoekstra, Romme, Argelo, NIVE, & voor Logistiek Management, 1985) of the floriculture market, it is very much a push process, since products are brought to flower auction by the growers without giving prior notice of the timing and volumes. The distribution of transactions towards the right customer can start when a trolley arrives in the right buffer in the distribution area. This distribution is a breakbulk function done in reversed picking. In the future Royal FloraHolland and the customers want to shift the decoupling point more towards a pull driven system to get a more predictable process (Van der Vorst, Bloemhof & De Keizer, 2012). In this way the customer needs can be satisfied in a better way. Customers increasingly ask for a just in time and more demand-driven solution. This is only feasible if the supply is acting on this. For Royal FloraHolland this will have logistic consequences. Information about customers of specific products at certain times should be available and at the supply side the quality should be regulated.

An important logistical challenge are the variations in supply and demand per product and per period in time (Vorst et al., 2016). Next to the variations in the number of products, the quality of the perishables can vary a lot. Even during the transportation and storage process the quality of the product can still change. A robust concept in which quality is controlled throughout the chain will support the supply of a constant quality. If the quality is constant the demand will be more predictable.

This is an important development in the floriculture chain. Originally this supply chain has developed completely driven by products pushed into the market. Since the change in customer demand and internationalization, the supply chain needs to develop into this more demand-driven and flexible behavior.

Peak time process towards a 24/7 process with a storage function

With thousands of incoming trollies every day, the logistic handling of Royal FloraHolland is immense (FloraHolland, 2017a). After the start of the auction at 6AM the first flowers and plants can be distributed towards the right customers. The service level agreement (SLA) with the customers requires a throughput time of 2,5 hours from the moment of sale until the product is inside the customer box. Since the auction only takes a few hours, the distribution time of Royal FloraHolland is around 5 hours per day. This means that Royal FloraHolland has an exceptional peak process.

With new auction principles flowers can be ordered during the whole day, which supports the opportunity for the moment of distribution to be spread out over the day towards a more 24/7

distribution. For an ongoing distribution, the supply chain will need more and smaller storages than in the current situation. Now all products are stored at the same time, waiting for the auction moment. With a storage function for the flower auction, the auction house would change towards a traditional warehouse, where products are stored for short times until they are sold. A storage can be physically on one place or can be shown virtually when stock is still on transport.

A virtual storage in a supply chain would mean that wherever the product is located, it can be sold from that location and transported to the right location. This virtual storage could store a product from the moment it is located at the grower, during transport and at the final selling location, which is nowadays the auction house. In the developing digital world, this development could give important possibilities for the floriculture supply chain.

New competitors for the flower auction
Since the internet has become a worldwide standard, web based platforms with various goals are popping up. Even in the floriculture sector an increasing number of platforms are online for buying and selling goods. With market forces on these platforms, realistic prices can be determined, which could become a dangerous competitor for the flower auction house. Competition can lead to enormous financial consequences, since they could take over large amounts of market share. However, since Royal FloraHolland is a cooperative company of the growers and has market information going back to the nineteen hundred's, this will give the existing auction house an immense competitive advantage compared to the new market entrants.

Conclusion 3.2.1
With the described trends and developments in the floriculture market, the first part of research question Q1 can be answered: *Which trends and developments are already visible in the floriculture supply chain?*
Trends that are visible in the floriculture market are virtualization, collaboration, consolidation, start of hub-network, coordination, internationalization, more direct flows, changes of consumer behaviour, demand-driven and flexible supply chain, more 24/7 process with a storage function and new competitors for the flower auction.

Some of those trends are expected to have more impact on the floriculture chain than other trends. Trends and developments with the expected highest impact are consolidation, increasing direct flows and the change from push to pull resulting in a storage function in the chain. Those trends will be further analysed to find their relations to each other and how they improve the floriculture market.

Next to those trends and developments within the market, there are outstanding technological trends in other markets that could be applied in the floriculture market.

3.2.2 Technological trends and developments from other supply chains
Described customer demands in the last section leads to the need for specific technology as robotics or track & trace. Many technological developments have been created in the last few years. Most important developments and trends that could be applied on the floriculture sector are automation, robotics, blockchain, vertical farms and the idea of making the whole supply chain cooled to protect the perishables. Those technologies can play a key role in the physical improvements of logistics. Paperless information transition is a requirement to fulfil this.

These trends are more technology driven due to automation and artificial possibilities. Since automation processes can be optimized, paperless working can be achieved and robotic applications can be used in the floriculture supply chain. Internet of Things technology can be used for track & trace through the supply chain. Artificial light and humidity regulators can be automated to support vertical farming in urbanized locations. At last blockchain application could be used to support

finance and logistics. In discussion with Royal FloraHolland those trends are considered to be the most important market trends for the floriculture supply chain.

Automation and robotics
A trend that is recognizable is the trend of automation and robotics. New technologies will be used in the near future to support the distribution of flowers and plants throughout the whole chain. Those technologies should reduce the operating costs for Royal FloraHolland and other stakeholders.

Robots that could be applied within the floricultural chain are smart robots, determining quality or various other circumstances. Other robots could be automatic grippers to distribute buckets of flowers or autonomous vehicles driving the flowers around.

After years of automation a patchwork of IT systems has been designed and implemented over the various locations of the flower auction. Since the merger of the various auctions in the Netherlands, the IT systems are still not integrated. Most applications are different for each location and cannot communicate with each other.

Royal FloraHolland is working on an overarching warehouse management system and supporting IT systems that are future proof and will be general for all locations. It is important that this system is transparent and that is able to deal with advanced information. Improved transport status information and improved virtualization will play a key role in the future (Van der Vorst, Bloemhof & De Keizer, 2012). Such a system is required to make those improvements possible. This overarching system is a requirement for any robotics and a better working track & trace system for the plants and flowers. At this moment the locations for specific trolleys in the distribution hall of Royal FloraHolland and at the customer locations are not flexible, they are allocated only every few days or even fixed. Preferably those locations should be allocated real time, based on the amount of space needed for incoming trolleys and the amount the customer buys at that specific day. This requires a smarter IT system than the current one. Internet of Things technology and paperless distribution could be from great support to fulfil this service.

Track and trace
An inter-hub or even supply chain wide track & trace system can be possible in the future. A track & trace possibility of products in the supply chain could be used for many things such as planning of transportation and stock, to reduce changes for mistakes and to keep track of all logistic means as trolleys and buckets. Technologies as RFID, long range radio devices (LoRa) or GPS tracking could be used for track & trace. At this moment all trolleys of Royal FloraHolland are equipped with a RFID tag (Connor, 2007). This means that on a Royal FloraHolland location, they can keep track of the trolley. GPS and RFID can also be used for geo-fencing. This is a monitoring tool to track and control transport and workforce and could be applied at the various establishments in the floriculture chain (Papadopoulou, 2017).

This development is already very useful in the floriculture chain and is will be increasingly useful when better technology possibilities become available on the market for a good price.

Paperless distribution
With the introduction of automation and robotics, it highly undesirable to couple information to products by using paper. Paper labels are now used by the grower to attach product information and by the flower auction to attach distribution information and buyer information. In practice a lot of pollution is caused when those papers detach and fall on the ground. Automated information flows through the chain with the support of Internet of Things and a track & trace system could make papers unnecessary (Wierik et al., 2017). A paperless environment is also required for incorporating robots in the distribution areas since it is hard for robots to move around when there are many

papers on the floor. A fixed barcode or a very well sticking barcode could replace the role of paper as carrier of product information.

Internet of Things

A concept that could be used to virtualize the floriculture supply chain is the Internet of Things (IoT). With IoT, physical objects are virtualized by a digital representation (Verdouw et al., 2013). At this moment RFID is already used under transporting trolleys to know the location of products and transactions, but IoT could offer a lot more (Uckelmann, Harrison, & Michahelles, 2011). With the newest possibilities the virtualized products can be integrated with a business software or sales platform. With IoT all machines and objects can be connected to the internet and are able to communicate with each other. This real-time solution will make it possible for companies within the supply chain to remotely monitor all used assets. By collecting and combining data smart choices can be made (Frangos, 2017).

For the IoT concept tests have been performed with LoRa on the packaging of flowers to get more information regarding the location, type and quality of the flowers (Wiersinga, Program manager Flow, April 24, 2017). This system is provided as an end-to-end solution and is used to virtualize products by adding this long range, low energy, radio device to the packaging (Michorius, 2016). By incorporating a system like LoRa, business intelligence can be improved and services can be automated. In this way Royal FloraHolland will be the owner of more information and the sharing of information can be rewarded through incentives. With cloud computing this knowledge can be used to build an infrastructure that synchronizes supply and demand by using up to date techniques and tracking the goods throughout the whole supply chain (Satpute & Tembhurne, 2014). This makes IoT a revenue-generating infrastructural concept with interesting possibilities for Royal FloraHolland (Uckelmann et al., 2011).

In order to be able to guide the enormous data flow coming up with IoT the very fast 5G internet network will be needed (Hooijdonk, 2017). Furthermore, the software for analysing all incoming data needs to be improved. IoT also requires a lot of energy to make all devices operational. All those constraints will cause a problem for fast implementation of IoT.

Blockchain

Blockchain technology is a public virtual ledger that is anonymously shared with all members within the network. Transactions can be done by the blockchain platform and those transactions can be reviewed by all users. The information about buyers and sellers is very well encrypted and protected. This makes blockchain a very transparent and safe technology (Ross, 2015). Since financial information is saved at many locations at the same time, this creates an open system for transferring money without the need for a third party as a bank. The technology of blockchain serves the elimination of the double-spent problem (Pilkington, 2015). When financial intermediaries are unnecessary, payments can happen immediately. Next to this authenticity of data can be verified without those same trusted intermediaries (Mattila, 2016). Another advantaged of the blockchain is that is eliminates the double-spend problem by rejecting transactions when the same bitcoin is intended to be spent twice. Blockchain has three main applications: a faster and more secure payment with the use of bitcoins, financially securing goods to give small and medium enterprises the possibility to get money easier, and a circular economy (Erkin, TU Delft, May 2, 2017). The first two applications could be used in the floriculture chain. Since floriculture products are biodegradable, the circular economy is not very useful in this market.

A payment via blockchain technology happens directly when the order is made and does not need to be checked by a financial company. At this moment Royal FloraHolland is securing the payment to the growers of all transactions within 24 hours. This while customers can take many more days before they pay Royal FloraHolland for this transaction. Royal FloraHolland can save a lot of money

by using blockchain for direct payment and stop the financial security of payment. At the other hand Royal FloraHolland could lose a part of its value proposition since the growers do not need their security anymore.

At this moment blockchain is mainly used for transferring and saving financial information. In the future logistical information as location, circumstances, temperature etc. can be detected with blockchain technology. This would be very interesting for a perishable product like flowers.

Second application of the blockchain is the financial security of goods. The financial security of goods could be interesting in the case of floriculture. There are so many products on transport through the whole supply chain and every point of handling could cause damage or change to the products. Since responsibility and ownership of goods are separated at many points, a financial security of goods would be interesting.

Another advantage of blockchain is that the market is finding the cheapest and most convenient way to sell and transport goods. This is called an autonomous economy. An autonomous economy is recognized in the synchro modality in logistics and a different way of delivery of products. Instead of delivery with trucks only, innovative ways of self-driving vehicles and usage of personal cars will grow (Wiersinga, Program manager Flow, April 24, 2017). This is possible when all information about products and destinations are in one program and when they can find each other in that online program.

City farming in vertical farms

Vertical farming is already used in the vegetables and fruits industry to grow those products on small surfaces as cities or densely populated areas (NOS, 2017). Vertical farming has a few advantages. One of the advantages is that agricultural land can be turned back into hardwood forests (Despommier, 2013) and transportation times for new grown products towards urban places can be reduced. Both have a positive impact on climate change. According to Despommier (2013) vertical farming also reduces the use of fresh water for farming with about 70% and the production can be done around the year. This option of growing flowers and plants closer to where people live, gives a better opportunity to deliver those flowers and plants on demand and in the desired state of freshness. Large cities as Shanghai and San Francisco already adopted the idea of city farming to overcome the vulnerability of transport connections (Lawson, 2016).

Vertical farms are the perfect example of consolidation described in section 3.2.1. Vertical farms are also a kind of naturally formed hubs at the grower side. Since so many flowers and plants can grow together at one location it is easier to fill up a truck for transportation the next location.

Cold chain

A physical service that could reduce time pressure in the chain for perishable products would be the introduction of a cold chain (Wiersinga, Program manager Flow, April 24, 2017). In a completely cooled chain, perishables stay fresh for many more days, which makes it easier to transport them to everywhere over the world. However, this will cost a lot of energy and money and is hard to make a sustainable possibility. At this moment retailers are not prepared for facilitating a cold chain for floriculture. In flower shops and supermarkets, flowers and plants are offered in non-cooled rooms. Also in auction houses cooled storage is only available for the longer storage. It will take many years until a full cold chain in the floriculture market will be available. The distribution chains for fresh vegetables and fruits deal with the same problem of quality loss when the products are not cold. An emerging technology in the fruits transportation is humidification (Fabbri & Owsianiak, 2016). This technology releases a fine mist of water vapor. This water vapor protects the fruits of drying out and when it evaporates it cools the product as well. For the floriculture chain, this technology might help

to improve the freshness of the products while it is cheaper than transporting and storing all products in an air-conditioned area.

The floriculture supply chain is already partly cooled and will have an increasing amount of cooled steps. However, it will cost a lot of effort to cool the perishable product from the moment of cutting until it is on the vase at the consumer.

Conclusion paragraph 3.2.2
After this paragraph the second part of sub-question Q1 can be answered: *Which innovative technologies in logistics and ICT can be recognized in other markets to improve to future situation of the floriculture chain?*

Innovative technologies that can be found in other markets and might be applicable on the floriculture market are: automation and robotics, track and trace, paperless distribution, Internet of Things, blockchain, vertical farms and the cold chain.

Of all these described trends and developments, track and trace is the most likely to be applied in the floriculture logistics. In further analysis it needs to be determined which technologies will reach a market maturity in the floriculture market with in time for a mid-term strategy.

Conclusion 3.2
In this trend and development analysis the relevance of all trends for the floriculture chain has been described. In Figure 14 the origin of each trend is given. Trends and developments that are described are found in floriculture literature as DaVinc^{3}i as well as from interviews. Next to this the flower auction Royal FloraHolland recognizes many trends that are applicable on the scoped part of the supply chain. At last techniques are described, of which some techniques originate from other markets, that could be applied on the floriculture supply chain in the future.

To give a complete answer on research question Q1 (*What trends and innovations can be recognized to play in important role in the floriculture supply chain until 2030?*) an overview of all described trends will be given in Figure 16. This figure shows how all trends are related to the various stages in the floriculture supply chain. From left to right the growers, flower auction and the customers of the auction are shown.

In those three stages of the chain the applied trends are shown. A direct flow of goods is drawn around the flower auction house. Three trends, initiated by virtualization, are overarching the entire supply chain. They are drawn on top of the grower, auction house and customer. Under the three stages the hub locations of the flower auction with applied trends on these locations are given.

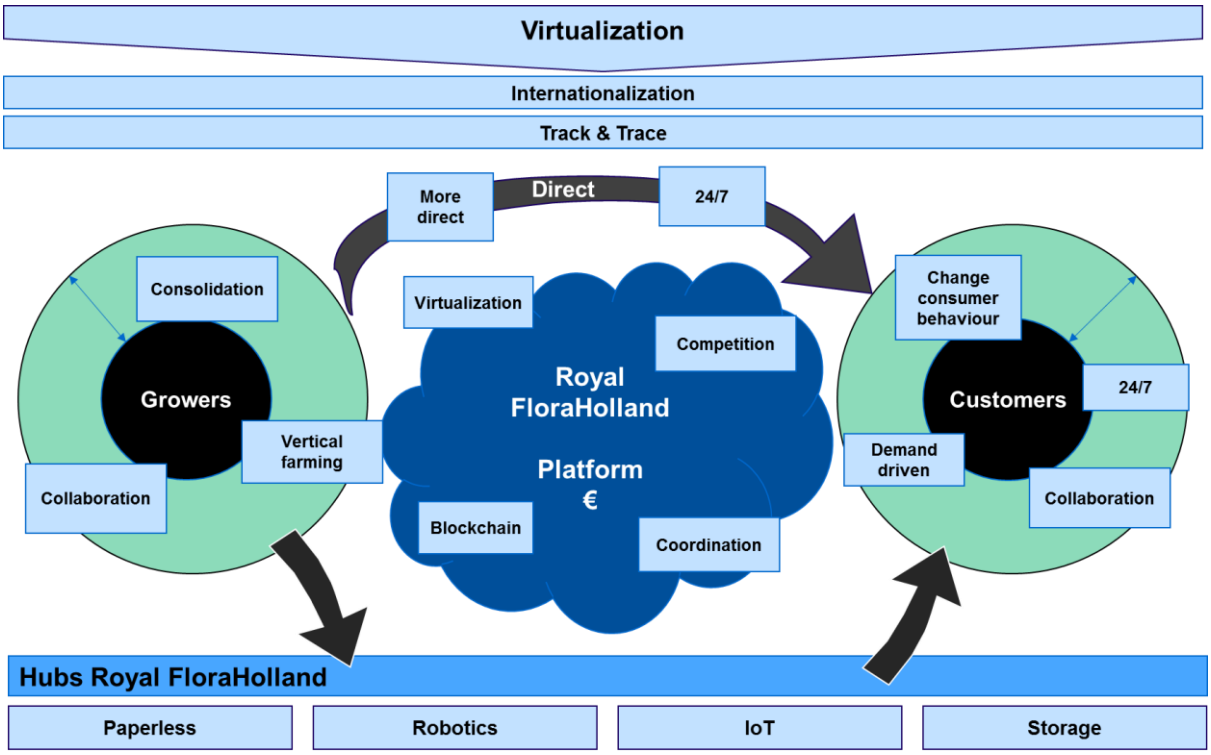


Figure 16, Floricultural trends overview

Described trends need to be combined with the current situation described in Appendix A3 (Stubbé, 2016) as well as some notable cases of the floriculture market. First a vision for the long-term situation is described in which important trends and requirements become visible as a whole. After this 2030 vision, a more elaborated analysis on the cohesion of the trends will be performed.

3.3 Combining trends into a long-term vision

From the literature study above can be concluded that certain trends will have more important effects on the future of the floriculture supply chain than others. Trends should be combined to find a clear vision for logistics. In this part the logistical vision for the whole floricultural supply chain for the long-term future will be described. From this paragraph until paragraph 3.5 the research question Q2 will be answered: *How can trends and innovations be combined to formulate a mid-term solution direction for logistics?* To answer this question first a long-term vision will be formulated in which the trends and developments are logically combined. In the next paragraphs additional analysis will be added to find the years to maturity of the trends and relations between the trends.

For the long-term vision in the floriculture market one thing is sure, products stay physical and need to be distributed from the location of the grower to the consumer. Growers are growing, internationalizing and even urbanizing and the market for floriculture around the world is growing, while the customer demand is increasingly specific. A 24/7 digital communication network will connect those worldwide customers with each other. In this digital environment financial transactions are formed. After the transactions are formed logistic services will be performed from grower to wholesaler, distribution centre, retailer and final consumer. The vision will be split up in financial, logistical and informational flows, but some trends described in one flow can play a role in another flow as well.

Financial flow

Currently the auction clock is still the most important instrument for price formation, this will probably change in the future. How this will change is up to the market and further research. The clock is now indispensable in the sector since growers use it with various strategies to get a high price

for their product. Timing (by draw), scarcity and buyer location are important factors for product pricing. Those factors are levelled out by the grower by sending his products to the various auction locations. When the clock is virtualized and brought to one platform where all similar products at the various locations are sold at the same time, this will have impact on the product prices. An increasing amount of floriculture is sold directly, to get a good price and constant sales. Products that are not sold directly are dumped for clock sale and sold against lower prices.

With a digital platform, growers can offer their products online for direct sales when they are still in its garden until the products are ready for transportation. Products that are not sold at the grower's place can be stored and sold from a virtual storage location. Prices will already decrease from this moment because of the insecurity of sales. When the life time of a product is running out, an auction system (clock or different type of auctioning) could be used to sell the remaining batches of products. Products that have not been sold have to be withdrawn. On the long-term all these sales mechanisms will run via one virtual marketplace.

The financial order on the virtual platform will lead to logistical services that are translated to logistical commands (e.q. transport, do break-bulk, store, withdraw). Those commands will be connected to specific costs. The total price for a product will consist of the formed price based on, amongst others, scarcity and quality, price for logistical services and the price for extra services.

When all products are traceable and virtualized, they can be sold at each moment. In the future the ownership of every floricultural product can change real time. This means that it will be possible that the ownership of each product can change at any point in the supply chain. In the oil industry oil is sold many times when it is still on the ship. In floriculture it is not expected to take such extreme forms, but a dynamic form of sales is foreseen.

Blockchain can be used for financial security of goods and provide in a seamless ownership transition, without payment problems. Royal FloraHolland could stop its activities of providing a guarantee of payment within 24hours to the growers since payment will occur directly. This will save a lot of missed income for the flower auction, but on the other hand, Royal FloraHolland will lose its uniqueness with this market value.

Logistical product flow

The demands of consumers are changing. People want to be more sustainable and ‘green’ and at the same time they are moving to the cities where houses and gardens are smaller. They increasingly want to order products at any time of the day and want the delivery of products at flexible times and places of their preference. This is changing the floriculture market rapidly. The direct flow is already increasing compared to the auction flow of products. Because of upcoming virtual marketplaces and changing demands, direct flow will keep growing.

In order to be able to plan logistics during any time in the supply chain, the exact life time of each product under every condition needs to be clear. Products need to be tracked, temperature and humidity needs to be controlled. This is also a requirement for creating a cold chain. Tracking needs a lot of digital technology and technological devices like GPS, RFID or LoRa.

On the long-term, transportation will still be needed from the grower towards a final customer. This can be directly or via stops at storages or distribution centres. Already from the garden the products need to be virtualized to create a virtual storage, Figure 17. The size of the cylinders shown in Figure 17 represents the number of goods that will be available in each stage. The changing height of the yellow cylinder shows that in every stage in the chain products are sold from the grower to the buyer. Even during transportation, the products are in this virtual storage and can be bought via the platform. From the moment of sales an optimal logistic service can be chosen. This virtual storage

will last at least until the moment of sales. The last moment of sale could happen in a distribution centre. Those distribution centres should be located strategically at hub-positions and could provide in two main services: storage and breakbulk. The breakbulk function can be fulfilled by robots. Autonomous vehicles, smart robots and conveyor systems can be applied to improve the internal logistics.

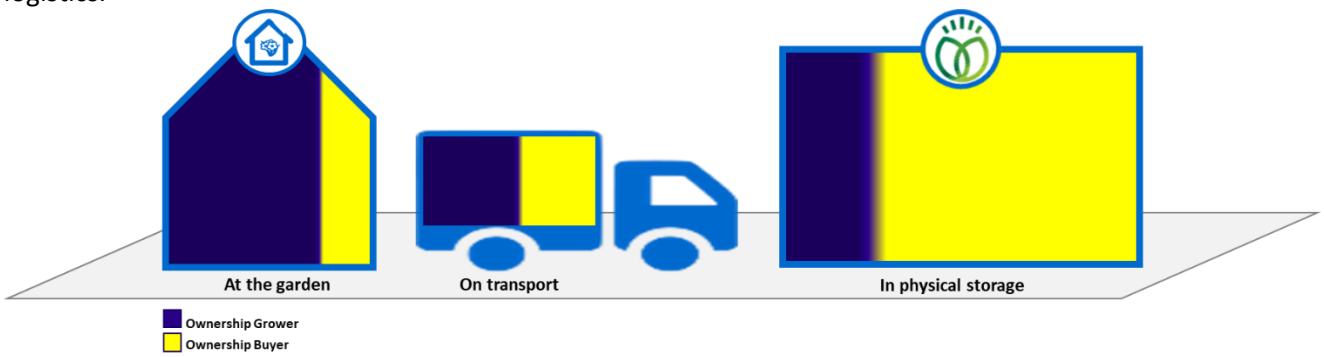


Figure 17, Virtual storage

Auctioning can take place at every moment in the supply chain: when products are on a hub-location or still in the grower's garden or on transport. In the food supply chain, the hub and spoke structure is already widely used (Ala-harja & Helo, 2014). Hubs are used as central nodes where products from the start of the supply chain come in and are redistributed and bundled to be transported to hubs closer to the final destination.

The auction locations of Royal FloraHolland Naaldwijk, Aalsmeer and Rijnsburg are originated in areas of many growers in the Netherlands and already fulfil certain kind of hub-functions. Using vehicle consolidation for combining loads from different suppliers in one vehicle and dropping it off at a hub-location could be used to make transport more sustainable and cheaper. Vertical farms will be an optimal case, since products are already consolidated before transport and often strategically positioned close to the customers. Multi-modal logistics or passenger car pick-ups can provide in this consolidation logistic model. With the internationalization, hubs should be created in other countries where many growers are. Next to this, main hubs in large customer countries need to be created. In this way the flow of goods can be transported directly from a main hub in one country to a hub in another country, which results in positive economies of scale.

Product planning with historical data can be applied. With knowledge of earlier situations, a number of specific products can already be sent towards hub-locations closer to expected customers. On each hub a storage function, a cross-docking function and a break-bulk function will be available. Since most types of flowers are no standalone product, a logistical service of repackaging and formation of bouquets could be implemented on certain hubs.

At this moment trolleys are logistically leading in the process since they are traceable because of RFID tag and barcodes. In the future products should be traceable per packaging or even per peduncle. This makes it possible to automate and robotize logistical processes on the hub-locations. Storing, break-bulk functions and cross-docking can be speed up and optimized using various techniques and algorithms.

Information flow

Real time information flows through the supply chain, will be increasingly important. Information about location, product, temperature, quality, transactions and logistic means are essential. This can be supported by the Internet of Things. Tracking and tracing through the whole supply chain from grower to consumer, needs to be supported. A multidimensional logistic system should be able to

connect information about the product, to information from the sales platform and the logistical command that has been chosen for delivery of the product.

This tracking through the whole chain is a requirement for using blockchain to secure goods. If it is known where every product is located and what its value is, blockchain technology can be used. The blockchain can grant each product for a specific value. After a transaction done via the blockchain, the new value will be attached to this product. In this way a bank can use the security of blockchain asset values as information for giving out loans. This will increase the amount of product movements in the market. Blockchain can eventually also be used for logistical data. Temperatures and locations for example can also be attached to a product and registered in the blockchain technology.

The information flow through the whole supply chain needs to become paperless. This means that all companies in the chain should be able to work with the same information messages. Royal FloraHolland could set a standard that needs to be followed up by growers and customers. The auction house should take a coordinating role in the supply chain by setting standards and managing the virtual platform. From this platform logistic orders can go out to third party logistic companies. All companies in the supply chain should have a good collaboration to make the chain more efficient.

3.4 Gartner hype cycle

Now it is clear which trends are most important in de floriculture market, it is important to visualize market maturity for those trends. Some trends are prerequisites for others. The company Gartner created a diagram in which technologies are plotted against the market maturity and the possible time the innovation can enter the market (Forni & Meulen, 2016). The latest diagram created, dates from July 2016 and is shown in Figure 18.

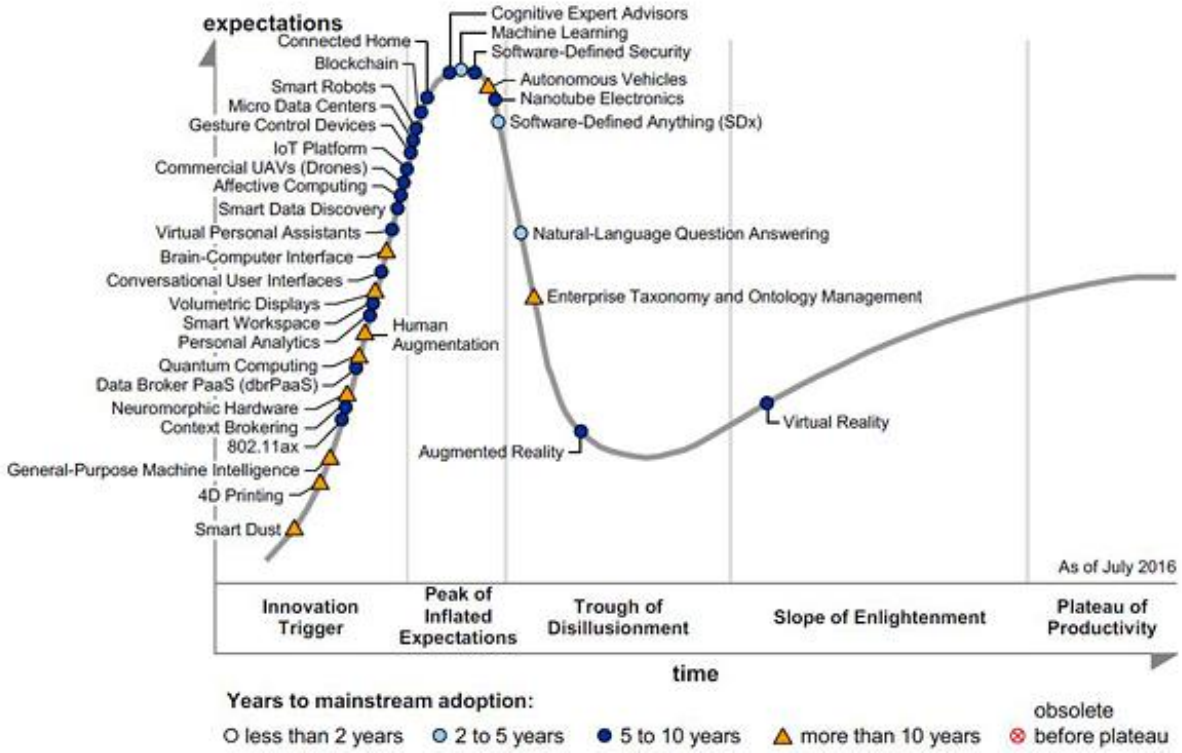


Figure 18, Gartner diagram as of July 2016 (Forni & Meulen, 2016)

Some trends described in the trend analysis of the floriculture market can be found in this diagram, namely IoT, smart robots, block chain and a derivative of the smart robots: autonomous vehicles. A Gartner diagram can be drawn for all described trends in the analysis. In consultation with senior

consultant chain logistics Bas te Wierik and project manager new logistic chain Nicole Slijkerman from Royal FloraHolland the expected market maturity of the specific trends has been determined. The four trends from the original Gartner diagram can be copied into the diagram applied on this market. Since some parts of the floriculture market are quite conservative compared to other markets, the expectation for the application of financial blockchain in the floriculture market has been changed to more than 10 years. The accountability for the positioning of all trends in a hype cycle for the floricultural market is shown in Table 2.

Table 2, Accountability floricultural hype cycle

Trend	**Years**	**Positioning in Gartner cycle**
Increasing direct flow	2-	Direct flow is already increasing for many years (3,8% in 2015 and 7,5% in 2016), this affects the flow of products passing the auction houses (RoyalFloraHolland, 2016)(RoyalFloraHolland, 2017).
Demand for personalization	2-	People are increasingly moving to the cities which also changes the consumer demand (Ven, Manager communications Let it Grow, May 19, 2017). This already affects the floriculture supply chain.
Virtualization	2-	With a digital floriculture platform the flower auction house has started to virtualize their main business of flower sales (ANP, 2017).
Intra-location Track&Trace	2-	Track&Tracing of products is of all times, however the technologies performing the tracking and tracing are improving. Within two years from now, all locations used for the floriculture supply chain could make use of a form of Track&Trace.
24/7 flower orders	2-	Just as in other markets people want to order flowers more 24/7 instead of only between 6 and 9 on the auction clock (Tandoyo, 2017).
Online competition	2-	Growers themselves and direct customers from the growers already have some online platforms where they offer flowers for sale. My expectations is that the amount and size of platforms will increase in the next years.
Collaboration	2-	Due to the short communication connections via the internet it has become easier to collaborate with other companies. This trend has started many years ago, but still many flows are managed independently. This should be improved due to changing end-customer demand (Vorst et al., 2016).
24/7 flower delivery	2-5	The floriculture market becomes increasingly demand driven for a more just in time, 24/7 delivery (Vorst et al., 2012). At this moment many steps need to be taken towards more just in time delivery, this will require a lot of organisation and planning. Because of this, this trend is expected to be market mature in about 2 to 5 years.
Paperless supply chain	2-5	Paperless logistics in the floriculture market is starting to be implemented at some stakeholder locations. However, through the chain there is no clear paperless product and status information. It will require a lot of supply chain overarching management to create this, at least two years will be needed.
Coordination	2-5	Same as for paperless logistics a lot of supply chain overarching management is needed which takes time.
Supply chain Track&Trace	5-10	Track&Trace can happen in many stages of the supply chain. Creating a Track&Trace system that follows specific products from garden to consumer will be complex. It will take much time to connect a tracking system to each product, instead of only to the packaging of a batch of products. Since transactions are often only parts of trolleys and parts of transactions (stems) are combined into bouquets, the batches will not be delivered to the consumer in their original state. This requires a more detailed tracking with

		high implementation costs and time. To enable a supply chain wide tracking application it will take at least 5 to 10 years.
Hub-network	2-5	Hubs need to be created or rearranged to provide the new functions. To create a network and rearrange buildings and functions some investments and change management is needed. Facilities for a hub-network could be finished within the next couple of years, the network structure needs more management and will need good guidance to be finished within 5 years. The first steps towards a network are already taken.
Storage function	2-5	Storage locations or a virtual storage need to be created strategically. According to Royal FloraHolland managers storage locations in the supply chain will change in the future. Changing physical locations and habits will take at least two years.
Consolidation	2-	The concept of consolidation is easy to implement or improve in many parts of the supply chain within two years. It is first described many years ago and later hyped by the DaVinc3i project (Hall, 1987)(Vorst et al., 2016). Consolidation thereafter has not been applied by many stakeholders. Communication between stakeholders is needed to improve consolidation.
Cold chain	10+	Measures have already been taken by some stakeholders in the chain towards a cooled supply chain. In this report cold chain is specified as a completely cooled supply chain from grower to consumer. Especially most retailers are not prepared to sell al floriculture products from a cooled environment. Next to this many processes at the auction house and its customer locations happen in a non-cooled environment. Every stakeholder is responsible to connect all links in the chain in a cooled way, it will cost a lot of time to connect all links from each grower to each consumer (AbyssiniaFlowers, n.d.).
Autonomous vehicles	10+	This trend comes from the original Gartner hype cycle and is plotted at the same position on the floriculture hype cycle (Forni & Meulen, 2016).
Financial blockchain	10+	According to the original Gartner hype cycle and trend research the financial blockchain could be market mature within 5 and 10 years from now. Investment costs, data protection and the market fit will be constraints for blockchain implementation (Papadopoulou, 2017). Since many investments are needed in the floriculture market, the expectation for market maturity of the financial blockchain in the floriculture market changes to an implementation time of more than 10 years.
Smart robots	5-10	This trend comes from the original Gartner hype cycle and is plotted at the same position on the floriculture hype cycle (Forni & Meulen, 2016).
IoT platform	5-10	This trend comes from the original Gartner hype cycle and is plotted at the same position on the floriculture hype cycle(Forni & Meulen, 2016).
Vertical farms	5-10	Vertical farms are starting to be implemented in the coming years. It is plotted as innovation trigger since this trend is not used in floriculture market yet. A few vertical farms are operational, however a further exploration will be needed in the next 5 or more years towards market maturity (Despommier, 2013).
Logistical blockchain	10+	Logistical blockchain will be an interesting trend to apply in a supply chain as the floriculture chain. However, this application of the blockchain technology is really new. Since the market maturity of the financial blockchain on the floriculture market has been expected to take over 10 years, this trend will also take more than 10 years.

Now all trends with the timing to market maturity have been described in Table 2, they are plotted in the floriculture hype cycle in Figure 19. This overview can be used to see which trends could be feasible on the mid-term, so before 2025, and which trends will only be applicable on the long-term in the floriculture market. The coloured dots show in how many years this trend will be applicable in the floriculture market. There are four groups. The first group will be available between now and 2 years, so could be applied in the strategy 2020. The trends that are ready in the next 5 years are obviously ready to be used for the mid-term design. Trends that take more than 10 years are not feasible yet. Only the group of trends becoming mainstream in 5 to 10 years should be discussed before they could be added in a design. The white dots in Figure 19 are already in pilot phase or operational at this moment. For the trends with light blue dots important steps are already taken or planned. The trends with dark blue and yellow spots are more farfetched and can only come back in a mid-term or long-term vision. Furthermore the hype cycle has been plotted on an axis with the timing in the innovation timeline, from innovation trigger to plateau of productivity. Each trend or development has been plotted on the graph positioned on the timing in the way to maturity of the specific innovation.

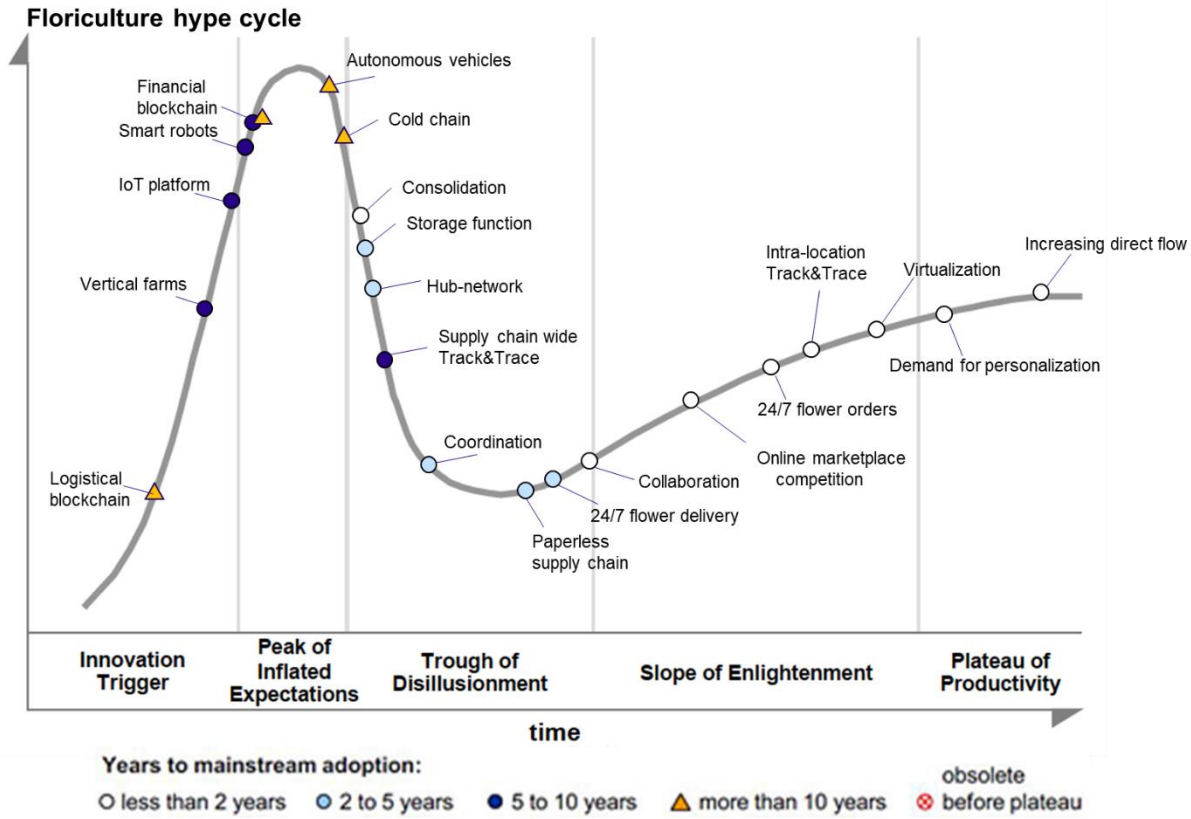


Figure 19, Floricultural hype cycle with described trends

Innovations that are under research but not yet tested in the floriculture market are logistical blockchain, vertical farms, Internet of Things platform, smart robots, financial blockchain and autonomous vehicles. In the floriculture chain the autonomous vehicles will possibly be automatic guided vehicles (AGV's) that can transport trolleys of flowers autonomously. Those innovations could eventually be used in the floriculture chain. Innovations that are available as prototype or tested in the floriculture sector are given in the Trough of Disillusionment. A general coordinating online platform will take 2 to 5 years before it is up and running on the floriculture market. Such a platform will be a trigger to create supply and delivery hubs closer to the growers and final customers, since flows can be coordinated easier and can be consolidated better. To do so a supply chain wide track & trace system is needed that follows and coordinates the product flows. Some track & trace possibilities can be available in the next few years, however a track & trace system that covers the

whole supply chain will last at least five years. This informational supply chain wide system should form a basis for the physical supply chain wide cold chain. Many parts of the floriculture supply chain are already cooled, but not every part. Especially the retailers are not prepared for the cold chain and in the auction house many steps in the process are still uncooled. Next to this historic cooling information needs to be added to every product.

Steps are already taken towards a paperless supply chain with digital freight messages and RFIDs on the trolleys. However, to unify every step in the floriculture chain and to make it all paperless will take at least 2 more years. There are already a few online marketplaces in which flowers are sold 24/7. One of those has been bought by the flower auction. These online platforms cause a lot of competition but give great opportunities as well. More flowers will be available and a more personalized demand can be fulfilled. Systems to meet a demand for 24/7 delivery, will be available after a few years when platforms for private transportation are more common. In this case a random person can transport any product and will get some money for this. A 24/7 supply and delivery leads to a fine-grained distribution and asks for a storage function as close as possible to the final customer.
Combining the trend descriptions with the resulting Figure 16 with the results from the floriculture hype cycle, Figure 19, the trends can be plotted on the timeline of the introduction. This overview is visible in Figure 20.

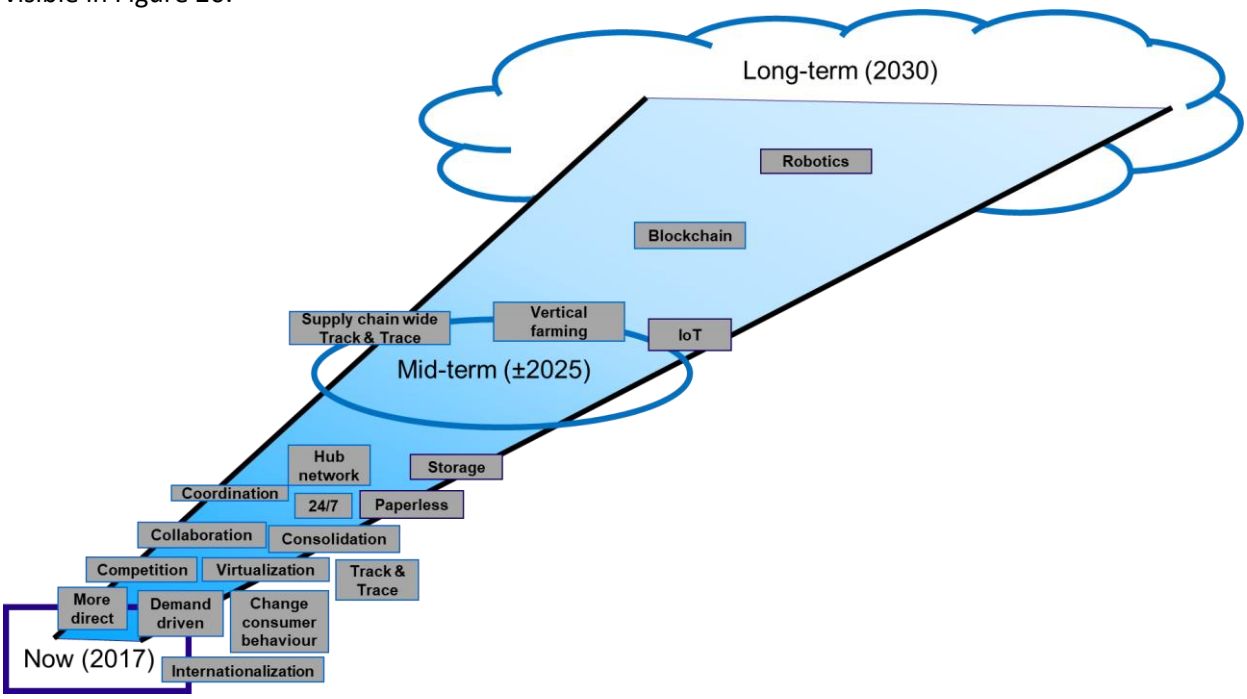


Figure 20, Expected market maturity of trends plotted on timeline

Based on all described trends and the mapping of those trends in a Gartner cycle, a morphological overview based on Zwicky (Zwicky & Wilson, 1967) can be made in which year trends are market mature. This overview is given in Table 3. The overview is comparable to Zwicky's model since it is multidimensional and unquantifiable. The discrepancy is in this case that the design goal is not a product but a combined plan. In this table some trends are not given since they are not easily to position on the Gartner hype cycle. Those trends still need to be taken into account.

Table 3, Overview of trends acting in the Gartner cycle

	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Storage function	Consolidation	Changing demand	Online market place competition
	Collaboration	Increasing direct flow				Virtualization
2 - 5 years		Coordination	Hub-network	Paperless distribution	24/7 flower delivery	Coordination
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		Supply chain wide track&trace				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

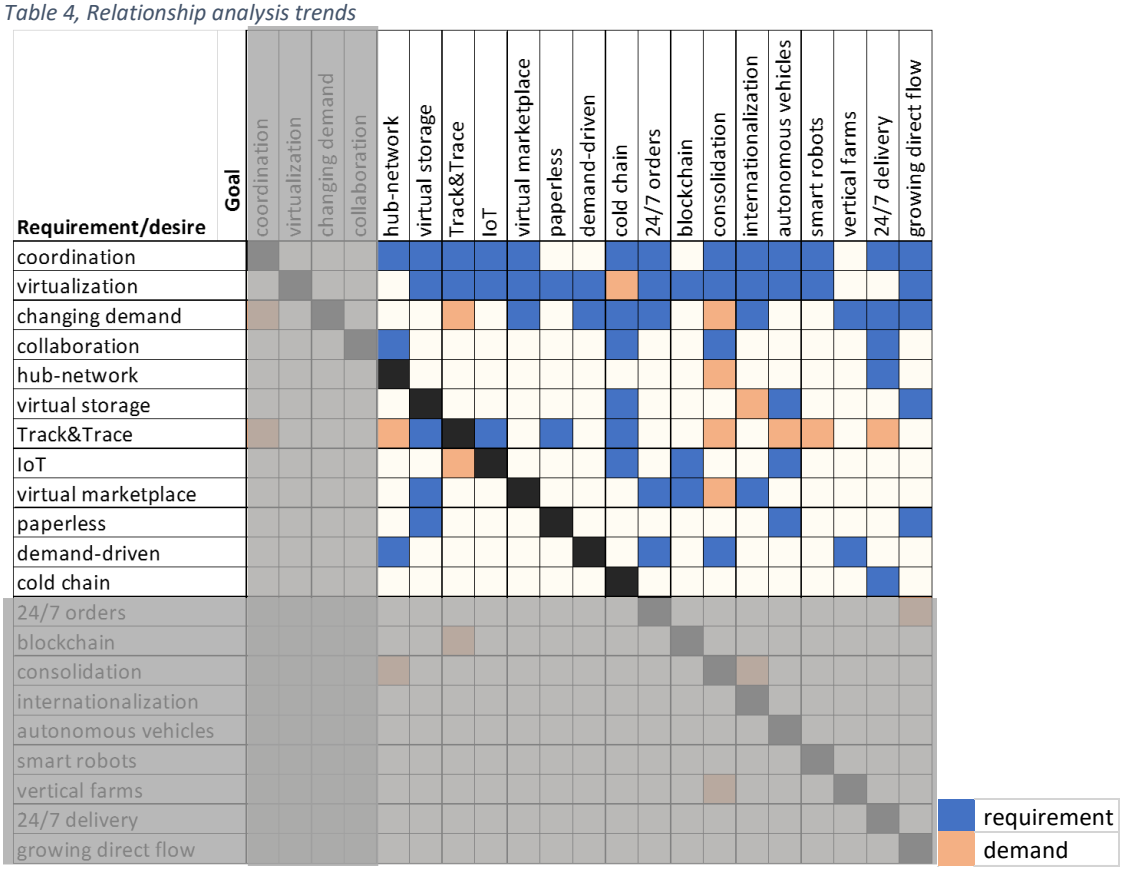
<u>Conclusion 3.3</u>

Now an overview has been given for which trends for the floriculture market become available at what point in time. The next step is to find out which dependencies exist between trends, in order to know what trend needs to be available before another trend can be introduced to the market.

3.5 Finding future solution directions

In order to find directions for a conceptual design for the future, the trends found above are clustered. In order to cluster those trends a relationship analysis has been performed. The analysis shows which specific trend is required for another trend to be successful. To find the relations between trends, a matrix is built to show which trend is required or desired for which goal trend, see Table 4. In this table a blue square shows that a trend is required as enabler for another trend and an orange square represents a desire for having the trend implemented before the new trend starts. A blank box represents no relationship. The given trends are do not have constraints to other trends.

Table 4, Relationship analysis trends



A trend can only be included in a design, if the required trend is available. A problem is, that when the required trend lags in its development, the target trend will be ready on a later term. Backtracking is needed to find out the line of development for each trend. Since in Table 4 only blue spots represent requirements, the lines and columns without blue spots are displayed vague.

Most of the described trends could make the floriculture market more efficient. Since trends affect other trends in their timing of the introduction to the floriculture market, it might be possible that technologies will have a later introduction than expected. Technological trends as robots, cold chain and blockchain have a physical impact on the quality of the product. Track & trace is used to control the physical product flows and optimize processes. In Table 4 is shown that in order to be able to use track & trace it is required to dispose of the trends coordination and virtualization. Those trends are initiators for the trend track & trace. At the other hand track & trace is a requirement and initiator for other trends. For example, a virtual storage and paperless distribution will not be possible without the track & trace information technology.

The dependencies as given in Table 4 are sketched in a dependency diagram in which all requirements are sketched, Figure 21. The yellow trends are the initiating trends. Those are already ongoing in the floriculture market and there are no other trends required for fulfilling these trends in an optimal way. The blue trends, like track & trace are the linking trends as described above. Those trends have other trends as fixed requirement, but they are also required for completing other trends. The linking trends are crucial for the development of all other trends. The last trends, the green ones, are the resulting trends and developments.

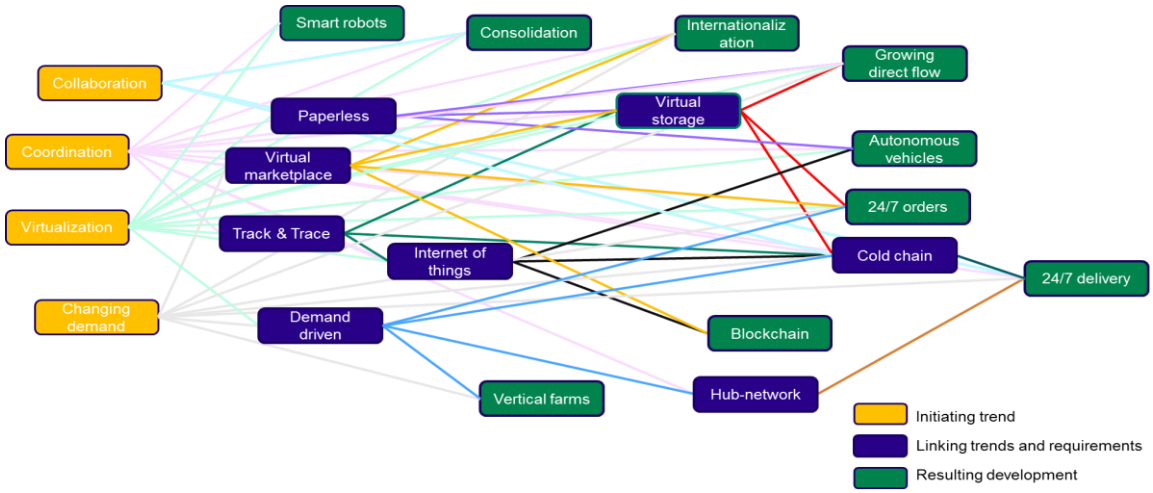


Figure 21, Dependency diagram of requirements for different trends

Looking at all resulting trends (green) two types of trends are recognizable. Some trends are needed to keep the business of the flower auction house operational in the future and others are just nice-to-have. According to Table 3 the maturity level of some trends is too low to be implemented on the mid-term. Trends of which the maturity level is too low for the mid-term vision are logistical blockchain, autonomous vehicles and cold chain. Financial blockchain, smart robots and internet of things are expected to be ready to enter the market between 5 and ten years from now. Since the floriculture market is not high tech at all stages, they are not expected to be completely implemented in this sector in the mid-term. Track & trace is already partly implemented and can be expanded over the years. In a supply chain wide track & trace system it would be highly desirable to use an IoT solution for this function. However, the simple tracking functions can be done without the Internet of Things. Furthermore, vertical farms could probably be mature in the mid-term, however, this is a nice-to-have and only operating in the first part of the floriculture chain.

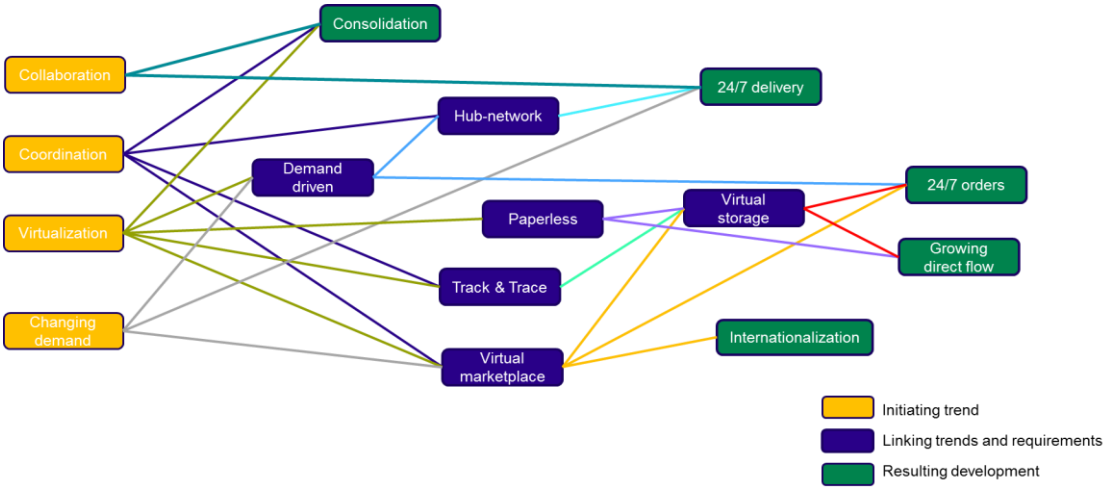


Figure 22, Reduced dependency graph with feasible trends for the mid-term

By leaving out the unrealistic and nice-to-have trends, the dependency graph of requirements for trends can be reduced to get a clearer view on the dependencies. In Figure 22 the reduced dependency graph is shown with only the feasible and more interesting trends for the mid-term. Next to this the lines from the initiating trends to the resulting trends and developments are removed in cases where those initiating trends where already required for the linking trends.

In the dependency diagram the linking trends and developments form the bottom line of the trends overview. If those trends are met, all requirements are fulfilled to achieve the demanded goals. For

now, it is most important which line of trends will be elaborated on in a conceptual design, so which trend or development determines the solution direction for the mid-term future scenario of the floricultural logistic chain. In Table 5 the linking trends and developments are given as possible solution directions. From this list it is already discussed that the IoT technology is too immature to be widely used on the mid-term in the floriculture market. This is even a requirement for the cold chain, so this development will also be kept out of scope. In case a linking trend is required for another linking trend, this one will be included when the second trend is described and therefore not been considered as a key trend. The only two remaining linking trends are virtual storage and a hub-network. Those two will be further researched into a conceptual design.

Table 5, Determination of solution directions for conceptual design

	Solution direction	Constraints	Further research
1	Virtual storage	-	✓
2	Cold Chain	• Not feasible on mid-term	✗
3	Hub-network	-	✓
4	Virtual marketplace	• This is a commercial development only supporting logistics • Scenario 1 follows from this scenario	✗
5	Internet of things	• This is a requirement for scenario 2	✗
6	Track&Trace	• This is a requirement for scenario 1	✗
7	Demand driven	• This is a requirement for scenario 2 and 3	✗
8	Paperless	• This is a requirement for scenario 1	✗

Conclusion 3.4

After the analysis two solution directions are chosen to look into for the conceptual design of the floriculture logistics on mid-term. Now, the two solution directions with all related trends and developments will be further described to make sure all related trends are feasible on the mid-term and to have a clear description for design.

3.6 Description of solution directions

In the last paragraph has been concluded that virtual storage and a hub-network will be elaborated into a conceptual design. For each of those options a dependency graph can be drawn to make clear which fixed requirement affect the trends and final goals.

Solution direction 1: Virtual storage

For the virtual storage development, six trends are required, see Figure 23. Coordination in the supply chain is an ongoing growing process just as virtualization and a changing demand. Together with the technologies of tracking and tracing, a paperless chain and distribution process and virtual market places they form the basis for the virtual storage principle. This principle is basically meant to keep increasing the direct flow in the supply chain and make it possible for customers to buy floriculture products at any time they desire.

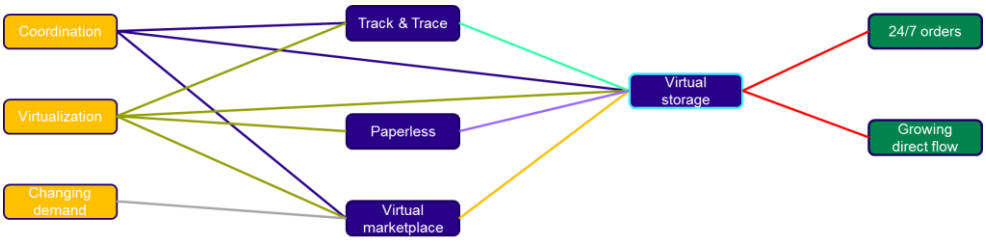


Figure 23, Requirements for virtual storage

Solution direction 2: Hub-network system

Just like the virtual storage principle, a hub-network can also function as a solution for the floriculture logistics on the mid-term. A hub-network can provide in a more effective supply chain with possibilities for 24/7 product delivery to the customer. Hubs need to be positioned in a strategic way in the world to be as effective as possible. To make hub-networks more effective, consolidation could be used for even more efficient transportation.

The initiating trends coordination, virtualization and a changing customer demand are required for an effective hub-network. The market becomes increasingly demand driven, which means that the supply chain will change from a push driven chain towards a pull driven chain. When the market is pull driven, so the consumer can have more influence on the product and its timing, this will enforce a hub-network. Those required trends and the connections are shown in Figure 24.

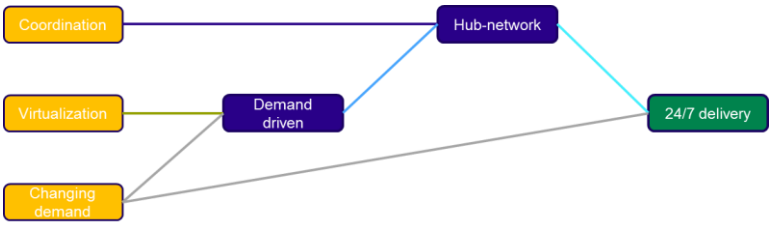


Figure 24, Requirements for a hub-network

In the last two figures only the fixed requirements for the solution directions are given. In the conceptual and final design desired trends can also be added. The resulting trends like 24/7 orders, do not only have the requirement of a virtual storage. A complete view will be sketched in a conceptual design in part B.

Conclusion chapter 3

With this research question Q2 (*How can trends and innovations be combined to formulate a mid-term solution direction for logistics?*) has been answered. The trend analysis has been summarized in Figure 16. A long-term expectancy has been described in which each trend has been located in the floriculture market. Afterwards all trends were plotted on the Gartner hype cycle. Here is found that not all trends will be feasible on the mid-term. A relation analysis showed that even trends that would be able on the mid-term were so much related to long-term trends that they are not feasible for this study. Finally, two feasible solution directions came out which could be combined with the design requirements in next chapter to come to a conceptual design.

4 Design requirements and constraints

In chapter 3 is described that a hub-network and a virtual storage are the core trends for the logistic mid-term vision in the floriculture market. The fixed requirements to realize these trends have been investigated. Those fixed requirements together with demands from within the chain will be divided into need-to-haves and nice-to-haves for the conceptual design. The third research question (Q3) will be answered in this chapter: What are the requirements for the design?

4.1 Need-to-have

Some requirements for design are extremely important those are described as need-to-have. Those requirements are split up in three sub-groups the product flow, informational flow and financial flow. The need-to-have requirements are collected from conversations with managers from different divisions and floor workers at Royal FloraHolland, others are derived from Royal FloraHolland documentation and interviews with stakeholders (Wierik et al., 2017), some follow logically from the trend analysis and others come from news items (ANP, 2017). Combining all these requirements found in those documents and conversations Table 6 has been formed. In the second column of this table the substantiation of each requirement is given.

Table 6, Need-to-haves for the mid-term logistic design

Product flow	**Substantiation requirements**
Different flows	In the current situation different flows of goods could already be handled. Towards the future even more flows will be operational, see Appendix A3 and the Royal FloraHolland 2020 vision (Stubbé, 2016). To do so, clear logistic actions per flow need to be formulated and performed. Paperless distribution will simplify the translation between product flows and actions.
Clear logistic actions	
Paperless distribution	
Increasing demand driven product flow (push to pull)	In the future Royal FloraHolland and the customers want to shift the decoupling point more towards a pull driven system to get a more predictable process (Van der Vorst, Bloemhof & De Keizer, 2012).
Increasing direct flow	Te Wierik describes the expectation of a growing direct flow in the coming years (Wierik et al., 2017), the design needs to be able to handle this growth. More direct flow initiates the possibility of 24/7 delivery. The market becomes more demand driven and changes towards a state where people demand the timing of ordered products (Wiersinga, Program manager Flow, April 24, 2017).
24/7 delivery	
Availability hub-locations	DaVinc3i already prescribed a hub-network (Ossevoort et al., 2014). In the interview with Wiersinga the added value of a hub network in the floriculture market became clearer.
Informational flow	
Handling of different types of information (products, flows, transaction types, etc.)	This is the information flow explanation of the paperless distribution described at product flow.
Track & trace of each trolley	Track & trace of each trolley is a requirement for paperless distribution and clear logistic actions. It is also demanded by the vision of Te Wierik and Wenink (2017) to track each trolley and to know the status.
Knowing the status of each trolley	
SLA being coupled to each transaction	For the pull/demand driven supply chain it is required that the demanded SLA is coupled to each transaction (Wiersinga, Program manager Flow, April 24, 2017).

Coordination of flows and tasks	In order provide the logistics with clear logistic activities it is required to coordinate all operational flows and tasks (Wierik et al., 2017). Preferably this will be visible in a virtual overview in a system that guides the logistical distribution. To do so, locations should be assigned ad hoc to perform tasks at that specific location.
Virtual overview of logistic activities	
Information system to guide distribution	
Ad hoc location assignment	
24/7 order intake	For a demand driven supply chain, it is preferable that customer can place their orders 24/7.
Financial flow	
Virtual marketplace	This 24/7 order intake will happen on a virtual market place on which products can be offered and sold at any time.

Described requirements will be used for the final design. First a design will be created that might fit most of the requirements. After the design is created, it will be tested which requirements have been fulfilled.

4.2 Nice-to-have

Next to 'need-to-haves' in a final logistic design for the mid-term, there are also trends that are desirable to be incorporated in the design. Those trends should reach a sufficient market maturity level before 2025 to be incorporated in the design. Other trends that are just nice-to-have are supply chain optimization possibilities, but not required for optimal functioning logistics on the mid-term. Those nice-to-have trends are given in Table 7 and since they are only desired and not fixed required, they will only be mentioned and not be further elaborated.

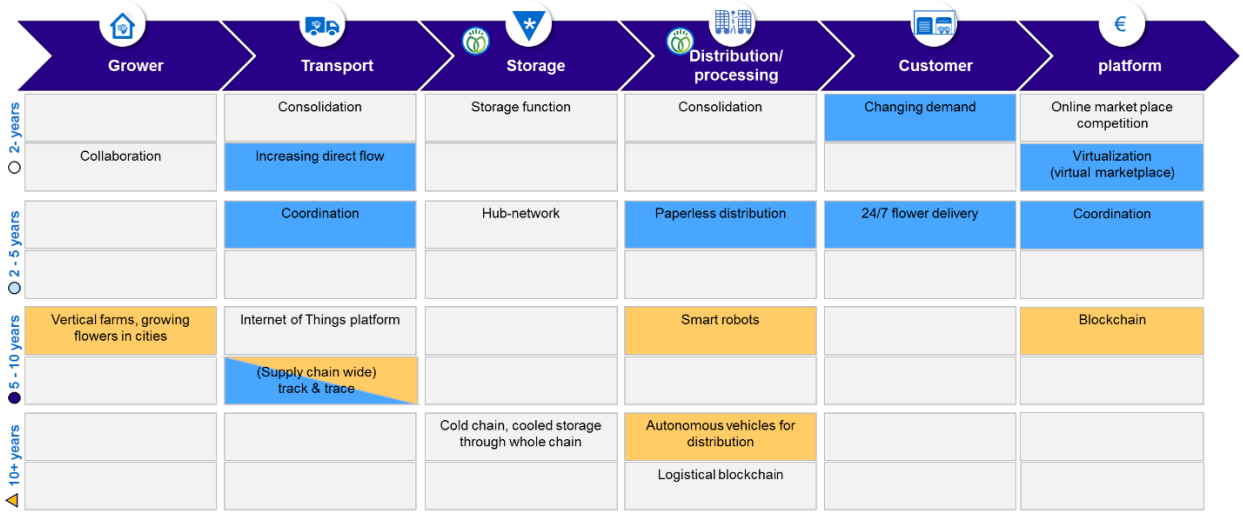
Table 7, Nice-to-haves for the mid-term logistic design

Product flow	Informational flow	Financial flow
Automate break-bulk process	Completely specify the position of each product, even the position of each packaging on the trolley	Transactions via blockchain
Vertical farming	Internationalized information flow	
Consolidation of goods	Virtual platform for transportation	
Internationalized product flow		
Smart robots / AGVs		

With these two tables for need-to-have and nice-to-have question Q3 (What are the requirements for the design?) has been answered. During the design phase the given requirements need to be taken into account.

Before the design phase can start, a clear overview is needed for which analysed trends and developments correspond to the given demands and requirements in the previous tables. This overview is given in Table 8. Corresponding to the relations table in paragraph 3.4, the fixed required trends are shown in blue and the nice-to-haves are given in orange. Only the box ‘supply chain wide track & trace’ has two colours. This is because it is a requirement for Royal FloraHolland to have a track & trace system on each trolley and buckets of products might be connected to those trolleys eventually, but a full covering supply chain wide track & trace system is too farfetched and not required for a new design.

Table 8, Trends as requirements for design according to Royal FloraHolland



	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Storage function	Consolidation	Changing demand	Online market place competition
	Collaboration	Increasing direct flow				Virtualization (virtual marketplace)
2 - 5 years		Coordination	Hub-network	Paperless distribution	24/7 flower delivery	Coordination
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		(Supply chain wide) track & trace				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

In the design phase described in part B, this table will be used to check whether the proposed designs meet the given requirements or not. The design will start without the use of this table to make sure the brainstorm process is not limited.

4.3 Constraints

Besides the requirements demands for design, there are also constraints. There are three important constraints in a project: quality, time and cost (Ebbesen & Hope, 2013). Not all three constraints will have the same importance for this design. The one with the main importance mentioned in the project scope is time. The scope for the final design is that it should be feasible on the mid-term, so be able to be implemented around 2025.

This project does not have clear constraints about quality and costs. In the end it can only be applied in the market is the costs are very low, or if the quality is that high that costs can be earned back easily. Goal of this design is to reduce mistakes and take away inefficiencies in the supply chain to be able to earn back money at some stages in the chain.

Part B

Elaboration of conceptual designs of chosen solution directions: virtual storage and hub-network. Combination of the two conceptual designs into one future logistics design.

Chapter 5 will describe the conceptual designs of the virtual storage function and a hub-network. In this chapter question Q4 will be answered:

> *Q4) What will a conceptual design for the flower auction in the 2025 situation of the floricultural supply chain look like, using the solution directions found in part A?*

In chapter 6 the future logistics design for the mid-term logistics will be described. In this chapter question Q5 will be answered, by first answering the sub-questions:

> *Q5) How can the chosen solution directions be combined into a final design and how to migrate from the current situation towards the designed situation?*
>
> *a. How can the solution directions be combined into a final design?*
> *b. What are the effects of the design to the key stakeholders in the chain?*
> *c. How does the final design meet the given requirements?*
> d. *What are the differences and similarities between the current situation and the operation in 2025 and what implementation steps are needed?*

5 Conceptual design

Part A of this report concluded with two solution directions, virtual storage and hub-network, and with the requirements for design. In this chapter research question Q4 will be answered: *What will a conceptual design for the flower auction in the 2025 situation of the floricultural supply chain look like, using the solution directions found in part A?*

Concluding from Table 8 in the last chapter, some trends and developments are required for the new design. In Table 9 all described trends are again shown at their operating position in the supply chain. This time the fixed required trends for the final design are market with an asterisk. After every described design, this table will be used to show which of these trends are incorporated in that design.

Table 9, Required trends for final design given with an asterisk (*)

	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Storage function	Consolidation	Changing demand *	Online market place competition
	Collaboration	Increasing direct flow *				Virtualization *
2 - 5 years		Coordination *	Hub-network	Paperless distribution *	24/7 flower delivery *	Coordination *
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		Supply chain wide track&trace *				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

In this first chapter of part B will be elaborated on the chosen solution directions. Combinations of parameters and requirements will be chosen to form a feasible conceptual logistic design for the mid-term. First will be elaborated on the solution direction virtual storage. A conceptual idea of the system will be described. Secondly the hub-network solution direction will be described.

5.1 Conceptual design of virtual storage

The first chosen solution direction is a virtual storage for the floriculture market. In the current situation there is no noteworthy storage function. Products are only stored to be sold at the auction clock at 6 o'clock in the morning every day. Goods are transported between and within locations when recourses are available, which makes a stock more coincidental than planned.

Figure 25 shows the current situation of the floriculture supply chain logistics. The different parts of this picture are explained in Appendix A4, Appendix figure 9, Explanation parts of virtual storage figure. Some products can be sold from the grower's location and other products will be transported to the flower auction house. Products that are sold at the grower's location will be divided in a group that is transported directly to the customer and a group that will be distributed by the flower auction, the so called connect flow or cross-docking. The direct flow of sold products is handled by the grower and the customer. Unsold products and cross-docking products are transported to the flower auction. At the auction house the two incoming groups are split up in auction flow products and connect flow products. The connect flow products are transported to the connect location from where the products are directly distributed to the right customer area. The auction flow products, the unsold products, are stored in a cooled or non-cooled area and need to wait for the auction

moment the next morning. This storage always takes less than twenty-four hours since all unsold products after the moment of auctioning are destroyed. After moment of sales via the auction clock the goods are transported to the breakbulk hall.

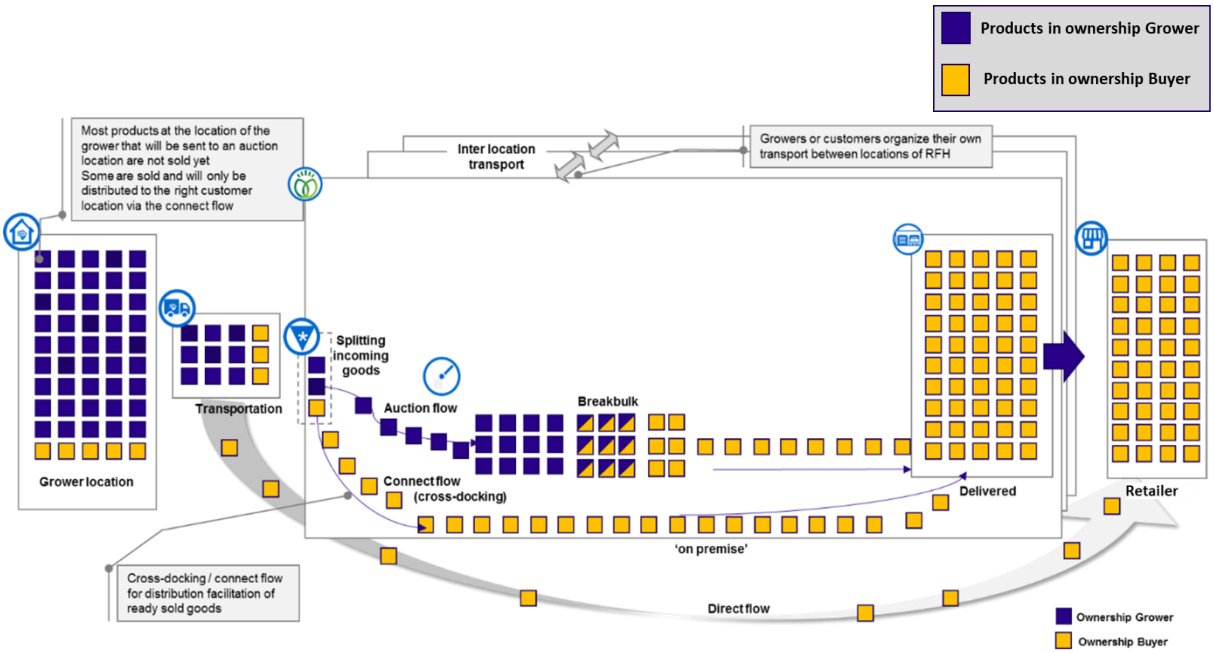


Figure 25, Current logistic flow

In a new situation a virtual storage function can be added to the current situation. A virtual storage requires a smart ERP (enterprise resource planning) information system that is able to follow each product from the grower to the customers of the auction. This ERP system needs to contain all information about the location, remaining lifetime and specifications of the product. A web shop can be linked to this ERP system to sell the products that are taken from the garden. This e-tail web platform can give information to the customer about the type of product and the system knows where the product is, so it should be able to calculate the estimated time of delivery. At that moment the ERP system can communicate with the logistical information system to take out that specific product from the storage.

In this case the storage is virtual. This means, different from a physical storage, that flowers are located in this virtual storage even when the flowers are still on the garden, when they are handled or on transport. During all those handling and transportation steps the flowers can already be sold. The final location of the virtual storage will be a physical storage, where the flowers will stay until their lifetime runs out. This physical storage location could be located on an auction house location. In Figure 26 the virtual storage function has been added to the figure of the current location.

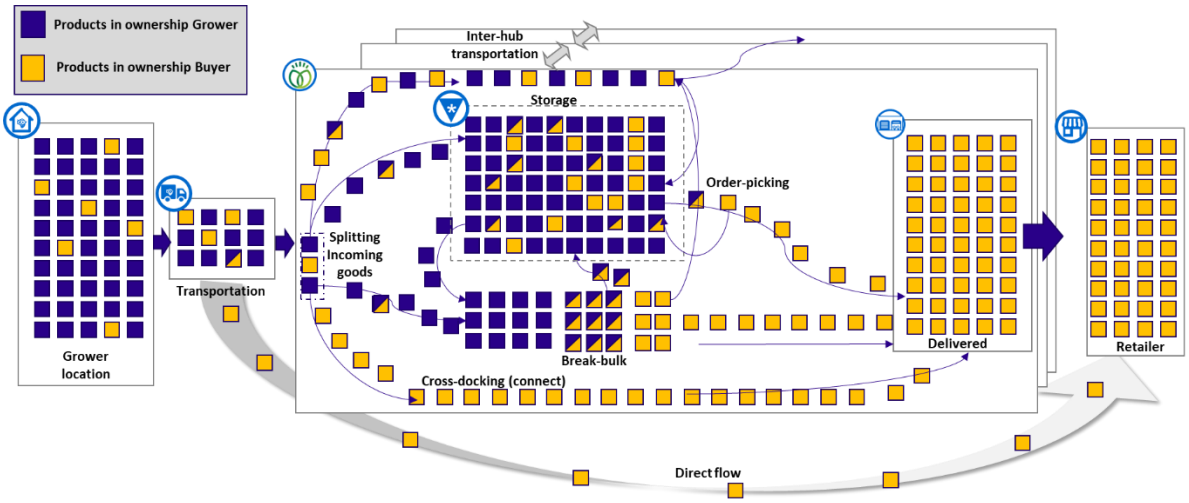


Figure 26, Sketch of logistic operation within supply chain, showing shift of ownership

Comparing the situation in the floriculture chain of Figure 26, Sketch of logistic operation within supply chain, showing shift of ownershipFigure 26 to the situation in Figure 25 it is shown that the products at the grower location and on transport can be sold at any time. Buyers can buy any product on the garden, on transport and in the storage. It could even be possible that the ownership of a product changes from the grower to a buyer and to his customers or consumers before it even reached the auction house.

When the products enter a distribution location or an auction house, the products will be split up into four groups: cross-docking (connect), clock auction flow (breakbulk), physical storage and to be sent to other flower auction locations. The cross-docking flow is for goods that are already sold, but where the distribution is done by the flower auction house instead of by the grower or transport company. The clock auctioning flow and the flow for physical storage are not sold when they enter the flower auction. Those products need to wait until they are sold via one of the selling mechanisms. When products are sold, breakbulk or order-picking can be performed to distribute the right products to the right buyer locations. Breakbulk is reversed order-picking. By performing breakbulk the grower trolleys are brought to various customer trolleys where the products are redistributed. By performing order-picking the customer trolleys will drive through the whole buffer to collect all products intended for that specific customer. The fourth group of products will be sent to other locations. Those products might be sold to buyers closer to that location or can be sent to another location because of another pull mechanism, like shortage of that product in the storage or an expectation for selling that product easier at the other location.

In the transition phase from the current situation to a situation with virtual storage, the four groups are a logical first step. Some growers are conservative and strongly rely on the clock auctioning, so this selling method will stay intact for the next few years. Eventually when the virtual storage and physical storage function have proven their worth, all products from the clock auctioning flow can first go to the storages. When the lifetime of the products runs out, a discount selling mechanism or auction clock can be used to sell the leftovers. This will change the picture of the logistic operation to a final conceptual design for the mid-term, shown in Figure 27.Figure 27, Conceptual design virtual storage function for the mid-term

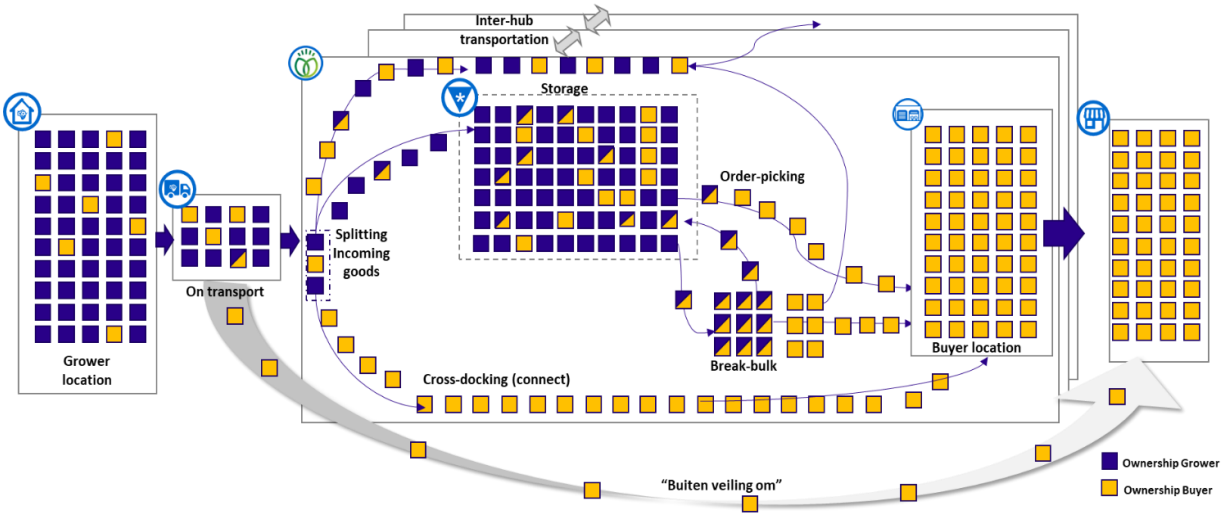


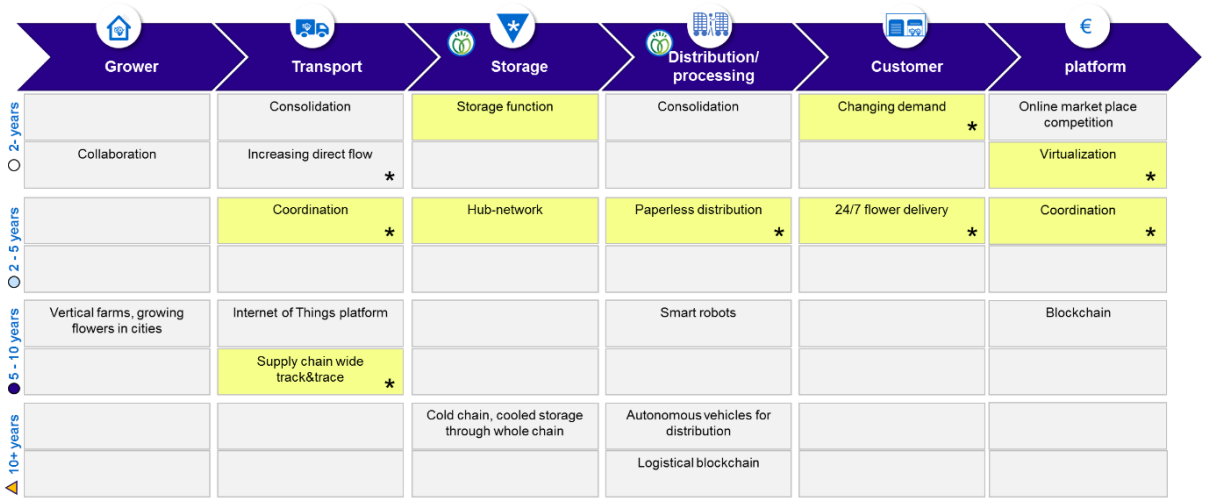
Figure 27, Conceptual design virtual storage function for the mid-term

In this final design can be seen how three groups enter the flower auction. The main group will be the storage flow. Goods that are sold in the virtual storage, can directly go via the cross-docking flow to the buyer. This flow is expected to increase tremendously because many more products can be sold before they enter the auction house. The last incoming flow will remain the flow for inter-location transportation.

A very important reason for a change towards a virtual and physical storage is because of the changing demand towards a more 24/7 or just in time delivery as described in paragraph 2.6. When the products are sold in an earlier stage they can directly be distributed to the right customer. Nowadays all entering products that are not directly sold need to wait until the next day before they are redistributed. This virtual storage selling can save up to roughly 20 hours per product (from the entrance of a product at the flower auction until it reaches the right customer, minus the time for direct cross-docking).

Next to those two applied trends to improve the floriculture logistics, 24/7 delivery and changed demand, other trends can also be applied in the virtual storage concept. Those trends are: virtualization, transport coordination, hub-network, paperless distribution, financial coordination and a (supply chain wide) track & trace function. In Table 10 an overview is given of the trends that are required for a well-functioning virtual storage concept. In this overview some trends and developments are indicated with an asterisk, those are the fixed design requirements given in chapter 4. For the conceptual design not all fixed requirements have to be met, but in the future logistics design they need to be met.

Table 10, Trends incorporated in mid-term design virtual storage, asterisks show requirements final design



	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Storage function	Consolidation	Changing demand *	Online market place competition
	Collaboration	Increasing direct flow *				Virtualization *
2 - 5 years		Coordination *	Hub-network	Paperless distribution *	24/7 flower delivery *	Coordination *
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		Supply chain wide track&trace *				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

It is already described how a changing demand and 24/7 delivery can be combined with a virtual storage function to improve the floriculture supply chain. The other yellow blocks from Table 10 will be described next. A coordinating system is needed for the virtual storage. This information system will use a track & trace method like LoRa to know where the goods are. The system should be able to coordinate the selling mechanisms and couple to a virtualized financial platform that coordinates all transactions. A smart, coordinating, transport management system will get a logistical command and should puzzle out the most efficient way of transport. This should all be supported by a track & trace system. When those overarching systems are collaborating in an effective way this could bring tremendous advantages for the buyer. This would make it possible for the buyer to order every product anytime he wants at every location and the delivery of the products can happen faster and at more desired times.

Preferably every single flower would be traceable throughout the whole supply chain, to make less mistakes and to make the supply chain more efficient. To do so every flower needs to be equipped with a bar code or tracking device. This is physically impossible and too expensive at this moment. For the mid-term it is a feasible aim to equip all boxes and buckets of flowers with bar codes and RFID-tags or IoT devices. Uniform scanners, induction loops or an IoT system need to be placed in the whole supply chain to track the products. At this moment within one building (at growers' location and at Royal FloraHolland locations) the tracking of products is already being done on trolleys and needs to be expanded to all packaging. When every packaging is equipped with a bar code or tracking device, paperless distribution will become feasible. The only requirement is that bar codes may not fall off of the packaging. Introduction of a paperless system will have financial impact on the grower. Initially the grower and the flower auction house need to pay for the more expensive tracking devices or bar code readers. However, eventually this investment will result in less mistakes, more efficiency and better products, that will pay back the investment.

A last trend that could be combined with the virtual storage function is the hub-network. Looking at the picture of the virtual storage conceptual design, three layers are given behind each other. Those layers are standing for the three export locations of Royal FloraHolland or three hubs. Nowadays the Royal FloraHolland hubs are only partly strategically used, the Naaldwijk hub towards the Rotterdam harbor and the Aalsmeer hub towards Amsterdam airport. However, it is still the decision of the growers where they bring their goods, based on historical demand patterns. With a virtual storage and an overarching transport/warehouse management system, the system can decide to send a batch of goods to another hub. Even when a truck has already started its trip, the system could

reallocate the destination depending to where its products are sold. The full conceptual design of a hub-network will be discussed in the next paragraph.

5.2 Conceptual design hub-network

The second chosen solution direction is the hub-network concept. For this design concept it is important to find out where the main nodes in the floriculture network are, to design a network of hub-locations. Furthermore, will be discussed what the advantages and disadvantages of a hub-network are. The designed hub-network will be compared with the given requirements for design from chapter 4.

At this moment there are a few important locations in the floriculture market. Those locations can be described as hub-locations. Hubs can be at many places in the supply chain: directly after the supplier/grower for bundling the supplies, hubs at the import side of the chain, a prominent market place, hubs right after sales for export, and hubs in the import or export countries or wholesalers. An overview is given in Figure 28. In this overview can be seen how hubs could be used to consolidate flows and eventually how the flows fan out again. Different from this figure, in the real market, jumps can be made to next hubs in order to get better prices or since steps are not needed because of distances.

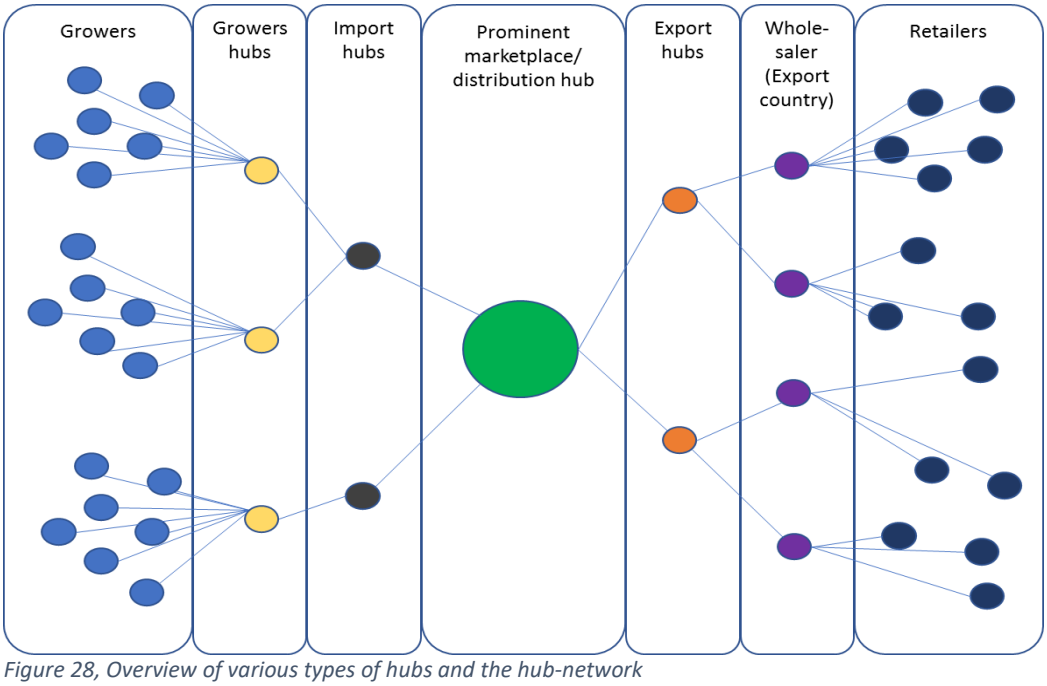


Figure 28, Overview of various types of hubs and the hub-network

An important new type of hub on the supply chain side of the grower could be the vertical farm. In a vertical farm many products can be grown at the same time and it could have the size of many growers. This makes it a hub by itself. If the vertical farm is built close to a market place it can be considered as a grower hub delivering directly to the market place. It could even be built very close to large cities. In this case it the vertical farm can deliver directly to hubs later in this picture or could even operate as a wholesaler with a fixed price.

For the hub-network analysis the EU market will be analyzed. According to the floriculture map 2016 the main trade markets in the world are US, Russia, Japan and EU (Rijswick, 2016). The first three markets are out of scope for this research, but could be interesting to analyze in another research. Looking at the infra-EU trade map of the floriculture map 2016, Appendix figure 3, the Netherlands is the most important player in this trading field. In the Netherlands the main flower trading locations

are the three export locations of Royal FloraHolland with the buyer locations often located in the same area. Many buyers have an establishment on the Royal FloraHolland locations.

In order to find the steps towards a hub-network for the EU flower market, numbers for import and export of flowers per country are required. In Figure 29 the list of floriculture export and import countries for the Netherlands is given with export/import numbers and growth numbers.

	Export value 2016	Share in total exports	Export value 2015	Share in total exports
Germany	1,661	28.9%	1,557	27.9%
United Kingdom	883	15.4%	925	16.6%
France	777	13.5%	753	13.5%
Italy	311	5.4%	304	5.5%
Belgium	256	4.5%	232	4.2%
Switzerland	188	3.3%	183	3.3%
Sweden	185	3.2%	176	3.2%
Poland	180	3.1%	174	3.1%
Russia	133	2.3%	169	3.0%
Austria	126	2.2%	130	2.3%
Denmark	119	2.1%	113	2.0%
United States	99	1.7%	88	1.6%
Czech Republic	89	1.5%	82	1.5%
Spain	86	1.5%	75	1.4%
Norway	65	1.1%	75	1.3%
Finland	58	1.0%	57	1.0%
Other countries	525	9.2%	484	8.7%

	2016 turnover	2015 turnover	Turnover change	Share of imports
Kenya	353	330	↑7.3%	44.5%
Ethiopia	179	180	↓0.4%	22.5%
Israel	63	59	↑6.3%	7.9%
Belgium	43	39	↑10.4%	5.4%
Germany	35	32	↑7.0%	4.4%
Spain	20	18	↑14.6%	2.5%
Italy	19	13	↑46.2%	2.4%
Zimbabwe	17	20	↓17.6%	2.1%
Denmark	17	18	↓8.8%	2.1%
Ecuador	10	11	↓3.4%	1.3%
Other countries	38	35	↑8.3%	4.8%

Figure 29, Import and Export numbers the Netherlands (Niewenhuize, 2017)

Assuming the Netherlands can be used as a starting point for a hub-network and analyzing the numbers in Figure 29, some logical hub positions to bundle and consolidate product streams can be thought off. Starting with the three important Dutch hub locations. Roles of those locations have changed over the years. The location originated close to grower locations to effectively sell their products. Nowadays transportation is faster and the locations do not necessarily have to be very close to the growers locations. They have a new strategic role close to the main ports Schiphol airport and the port of Rotterdam. It is also close to Hoek van Holland where the boat to England leaves. From the described hub locations, products will be transported in the direction of the final location to consolidate streams.

According export/import numbers and growth numbers in Figure 29, logical countries for hub locations can be determined. Smaller hubs are expected first in Belgium to offload locally bought products and to rearrange product streams towards France and Spain. In this way the truck load can be rearranged to improve the load consolidation of trucks. Another few hubs are expected in France for local distribution and distribution to Spain. The same can be said about hubs towards the east/north. A few hubs are expected in Germany for local distribution and one in the North of Germany to serve Scandinavia, one in the east to serve Poland and Czech Republic and one in the south for Austria and Italy. Those described export-hub locations are visualized in Figure 30.

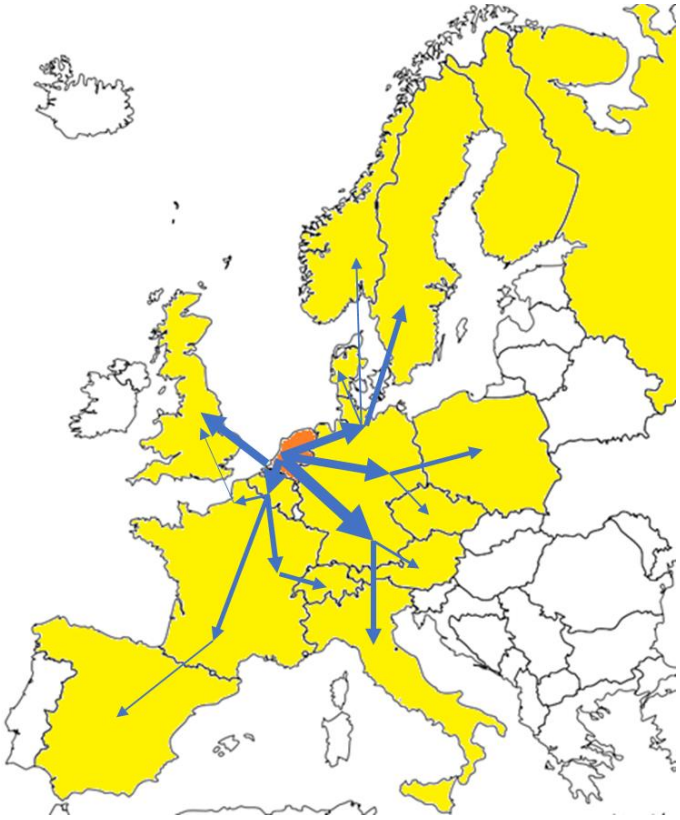


Figure 30, Hub map EU with export locations from the Netherlands

In Figure 30 smart ways of consolidation are shown. Large arrows represent tick flows of products and thin arrows represent the smaller flows to smaller retailers. Figure 30 is slightly similar to a thesis study performed in 2014 for which an algorithm has been design which had to calculate the most logical spots for import/export hubs (Verhoeven, 2014). In the study of Verhoeven, specific locations for hubs are given and the hub locations for local distribution within countries is also taken into account. Since specific distribution hub locations are not the key of this study, the results of Verhoeven are only given in the Appendix figure 6.

For countries outside the EU smart ways of consolidation before shipping could be interesting and reduce transportation costs. The key providing countries to the EU are Kenya and Ethiopia. For them it might be interesting to collect their floricultural products at a central hub close to those countries in order to reduce shipping costs and to transport in a more sustainable way. Other important countries shipping flowers into the EU are Israel, Zimbabwe and Ecuador. With smart hub-locations product batches might be transported directly from those production countries to large import countries. In European countries the export-hubs can be used for import as well.

An advantage of the designed hub-network is, with this strategic plan for the positioning of the hubs, transport streams can operate more efficient and effective. Truck loads can be increasingly consolidated which discourages trucks to drive (half) empty (Zeemeijer, 2016). In this case less trucks are needed and less empty trucks will be driving back. A strategic network as discussed here, can increase the direct flows in the supply chain and might speed up the total time of the product to retailer and consumer. This means that the consumer can enjoy the product for a longer time.

The design of the hub network could be supported by a smart transportation system. This system should be able to track all trolleys with products throughout the whole supply chain. With the system will be visible which product needs to be transported to a given location. The system will calculate

the smartest way of consolidating products towards their final destination. Transportation companies can register the size of their trucks and enroll for a ride to a certain destination. The system will calculate the value of the transportation and if there are more transporters who want the job, they can bid the lowest amount of money to get it. In this way transportation will become cheaper and more efficient. Larger batches will be transported for lower prices and less trucks will be driving empty since they can sign up for a new job from their final destination. This system works best if it is combined with other markets requiring transportation.

This system could be created and operated by Royal FloraHolland or a cooperation between transportation companies could set up a transportation system. The transportation system could possibly be created by a start up to earn money with every movement booked at the system.

A side note for the way the hub-network is sketched, is that the Royal FloraHolland auction houses are still the center point in the sales mechanism of the supply chain and their locations are still leading as in the current situation. Another side note is that the products are perishables and cannot be stored for a long time, and the products have such specific characteristics, that the export-hub-locations can only be used for sold products (Keizer, Haijema, Bloemhof, & Vorst, 2015). Perishable products cannot be sent to a next location in the network until it is practically sure that the product will be sold at that location or will not be sold at the current location. This can be seen as a disadvantage of the hub-network design for the floriculture market.

Last step to finish the conceptual design of the hub-network is to compare the given requirements to the trends and developments that can be incorporated in the hub-network design, given in Table 11. As discussed one of the great advantages of this concept is that it makes maximum use of consolidation and it limits transport movements. Collaboration between the growers is very important to form efficient grower hubs where transport can be consolidated, but also other services for the growers can be performed such as packaging. As described vertical farms can be a hub by themselves. With many hubs in each export country, just in time or 24/7 delivery will become easier.

In order to coordinate transport and to make it easier to increase the direct flow, distribution needs to be paperless and a well-functioning supply chain wide track & trace system is required. In the future an Internet of Things solution can serve this goal, but on the mid-term, implementation of IoT throughout the whole supply chain will not be feasible.

Table 11, Trends incorporated in mid-term design hub-network, asterisks show requirements for final design

	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Virtual storage function	Consolidation	Changing demand *	Online market place competition
	Collaboration	Increasing direct flow *				Virtualization *
2 - 5 years		Coordination *	Hub-network	Paperless distribution *	24/7 flower delivery *	Coordination *
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		Supply chain wide track&trace *				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

As explained in the previous paragraph a virtual storage function can be combined with a hub-network. Now the hub-network concept has been described more in depth, the advantages of using a virtual storage function at the import side become visible. The earlier in the supply chain a product is sold, the earlier the destination of the product is known. For some products this will result in rerouting the product for a faster way through the hub-network to reach the final destination faster. For example, when a product that is grown in Germany is on its way to an auction house in the Netherlands, it just arrives at a grower hub in Germany, when the system finds out that the product is sold to a customer in Poland. The product can directly go to the German hub exporting to Poland instead of first being sent to the Netherlands.

In Table 11 three boxes containing an asterisk are not incorporated in the hub-network concept. Those three trends are: changing demand, financial virtualization and financial coordination. This is because a hub-network can be started anyhow, without changing demand as initiator. The two main improvements that could be reached via changing demand, faster flower delivery of fresher goods and a more sustainable transport system, can be met anyway with the combined design as described. Furthermore, financial virtualization and coordination are not directly coupled to a hub-network. Only if the hub-network system is combined with the virtual storage concept, they will become interesting.

Conclusion 5

In the paragraphs 5.1 and 5.2 two conceptual designs have been elaborated, the virtual storage function and a hub-network. Within these two paragraphs Q4 has been answered: *What will a conceptual design for the flower auction in the 2025 situation of the floricultural supply chain look like, using the solution directions found in part A?*

The conceptual designs for the mid-term, a virtual storage function and a hub-network, are shown in Figure 27, Conceptual design virtual storage function for the mid-term and Figure 30, Hub map EU with export locations from the Netherlands.

6 Future logistics design

In the previous chapters the two solution directions virtual storage function and a hub-network have been worked out into a conceptual design. In this chapter a future logistics design will be elaborated, combining the two conceptual designs. Research question Q5 will be answered during this chapter:

Q5) How can the chosen solution directions be combined into a final design and how to migrate from the current situation towards the designed situation?

a. *How can the solution directions be combined into a final design?*
b. *What are the effects of the design to the key stakeholders in the chain?*
c. *How does the final design meet the given requirements?*
d. *What are the differences and similarities between the current situation and the operation in 2025 and what implementation steps are needed?*

Sub-question a. will be answered in paragraph 6.1 where the future logistics design will be described. In paragraph 6.2 the effects of the design on stakeholders are given, hereby sub-question b. will be answered. In paragraph 6.3 the design will be tested to the requirements given in chapter 4, with this the sub-question c. will be answered and directions for implementation are given to answer sub-question d. can be found in paragraph 6.4.

6.1 Elaboration conceptual design into future logistics design

As described in paragraph 5.1, the virtual storage conceptual design could work in a hub system. Paragraph 5.2 has concluded with the possibility to combine the two conceptual designs described. This paragraph will answer Q5a: *How can the solution directions be combined into a final design?* Figure 31 shows how the final design will be combined from the two conceptual designs described in chapter 5.

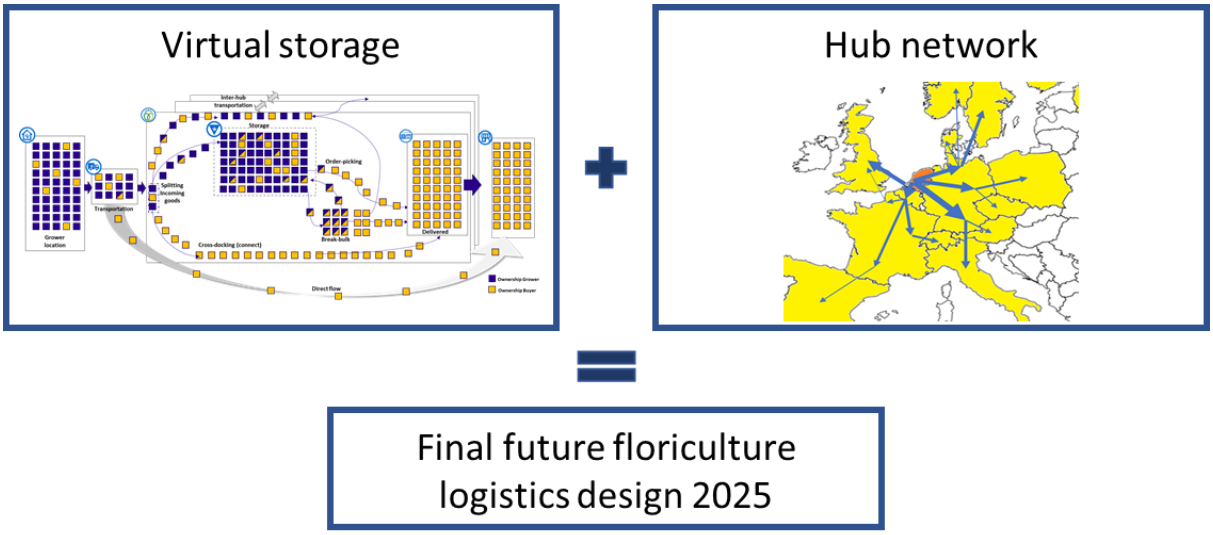


Figure 31, Combining two conceptual designs into final design

Combining the two conceptual designs will create a situation where hub locations are used for cross-docking, storage and breakbulk. Considering an optimal working virtual storage function, a separate marketplace hub would not be the central point in the supply chain anymore. The marketplace hub as it is nowadays, will change in importance level. When the virtual storage function will be applied on the floriculture market, and more goods will be sold before they enter a distribution location, the need for a physical marketplace decreases. Next to this, a requirement for the virtual storage is to have an online platform on which all goods are offered for sale. In fact, this online platform takes over the role of central marketplace hub as a virtual market place where the sales take place. This will result in the current physical marketplace hub changing its goal into an import/export hub.

The new picture of a hub-network in the floriculture supply chain is shown in Figure 32.

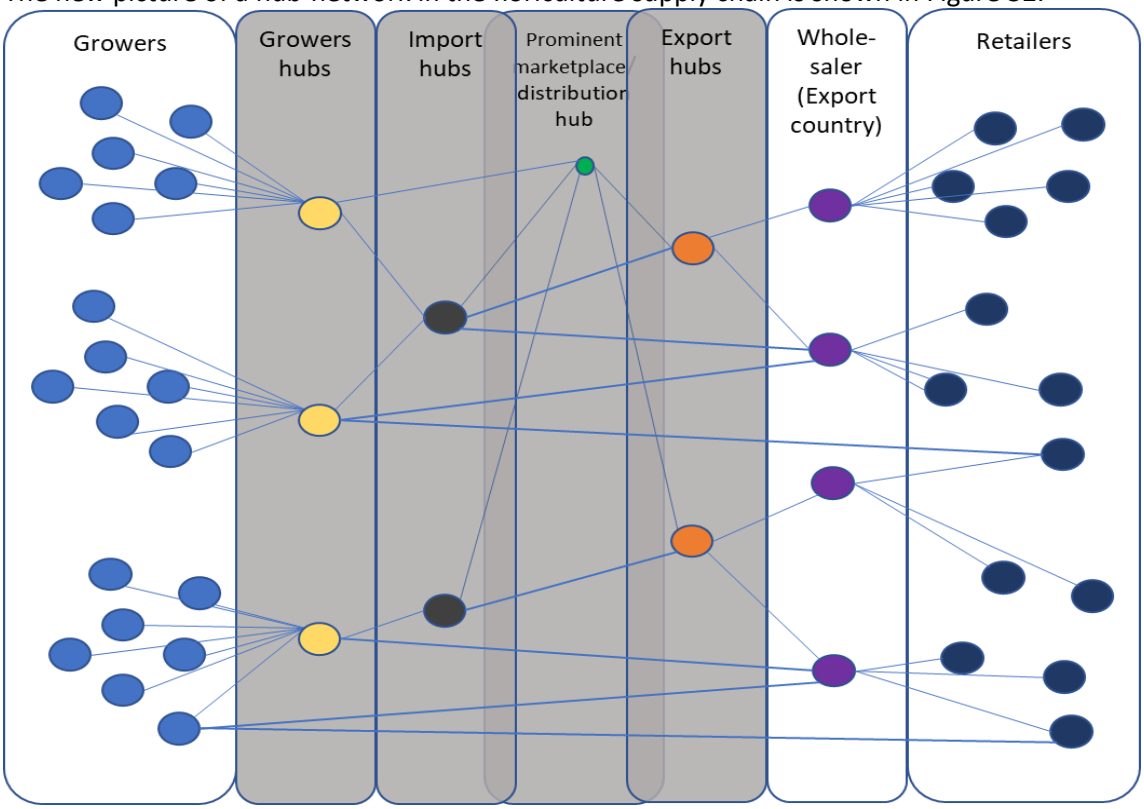


Figure 32, Hub-network structure with a virtual storage function

In Figure 32 is visible how the role of a marketplace changes when a hub-network and a virtual storage function are operational at the same time. The physical marketplace will only be used for specific products or by smaller growers and retailers. In this new situation import and export-hubs will become the key players in the network. The order in transportation between locations will change and an increasing number of products will be sent directly to a hub more at the end of the supply chain. The hierarchy in the chain concerning the order of transportation will blur (Craaikamp et al., 2017). In countries as Germany, the Netherlands, Belgium, Italy, Spain and Denmark flowers are both imported and exported. Hub-locations in these countries can process both flows as a combined import/export hub-location.

In case the virtual storage function is fully operational, products can be sold at every location. This means that the hubs between the growers and the 'sellers' (wholesalers and retailers) become a grey area. Therefore, the steps from the grower's hub until the export hub are marked grey in this new overview, Figure 32. Some hub locations will fulfill all tasks from receiving products from the growers, to storing of unsold products, to rearranging goods per destination or country. Incoming goods from the growers can be from local growers as well as imported goods from foreign growers. This is displayed in Figure 33.

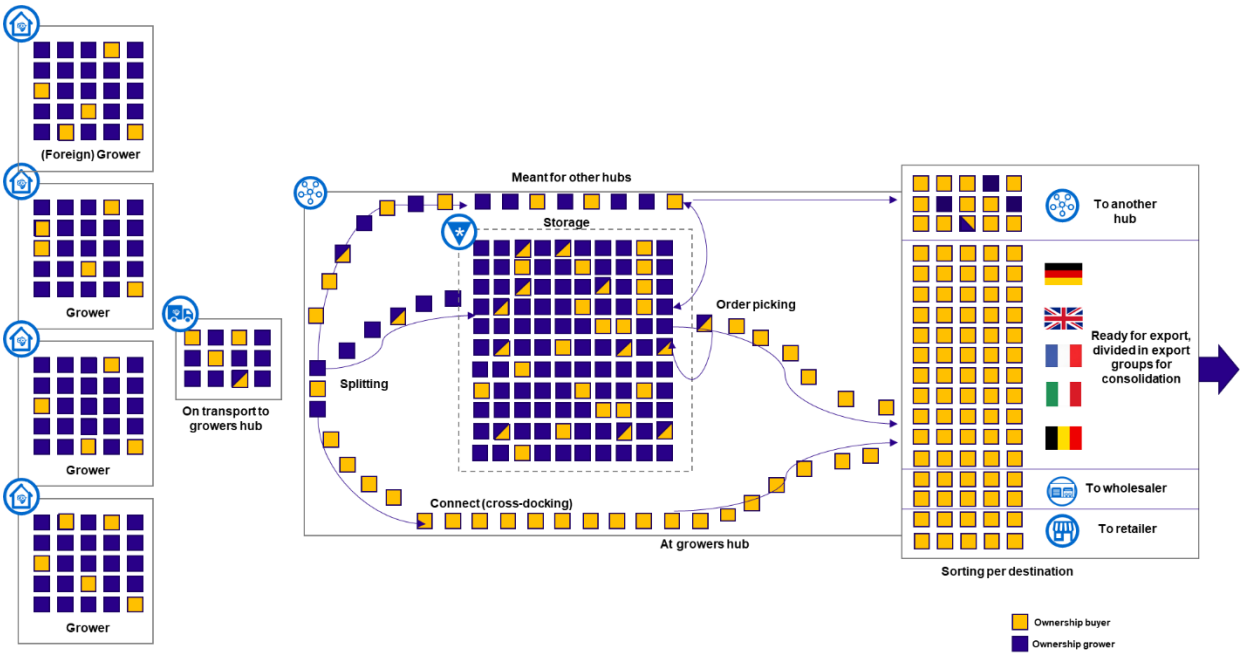


Figure 33, Schematic view growers' hub (in the future storage hub)

From Figure 33 it becomes clear how the main hubs will be used. Growers bring in their goods, as normal. The goods are split into three groups:

1) The unsold products go into the storage;
2) The sold products are cross-docked towards the delivery area;
3) A mixture of sold and unsold products meant for other hubs. Those products will be sent to another hub either because the storage space at one hub is full or when a specific product is expected to be sold close to another hub. This group is also cross-docked towards the delivery area.

In the delivery area everything will be prepared for transport in the most efficient way. Product streams are bundled before transportation. Most obvious way to split the stream is:

- Products are sorted per country of destination to be able to consolidate transport. If trucks can be filled up completely for one country, it can drive to the final destination. If the trucks are not completely full, it can drive to the closest transportation-hub to combine the freight of more trucks coming from other hub-locations. This can be coordinated by a transportation platform.
- The retailer and wholesaler in case of Figure 33, are expected to be local companies with short transportation times.
- Goods that are meant for ‘another hub’ are not always sold. Those products will be sent there either because the lack of storage space at one hub or when a specific product is expected to be sold close to another hub.

To simplify the story described above, the number of different types of hubs will be reduced. Since for example Aalsmeer and Rijnsburg both receive products from growers, they will both have a physical storage function for goods to be sold. Those hub-locations where products will be waiting to be sold will be called storage hubs from now on. There is one more type of hub left, this will be a transit hub, only meant to consolidate product streams towards a storage hub or to the final destination country. The final picture for the hub-network including an optimal working virtual storage function will look like the network in Figure 34.

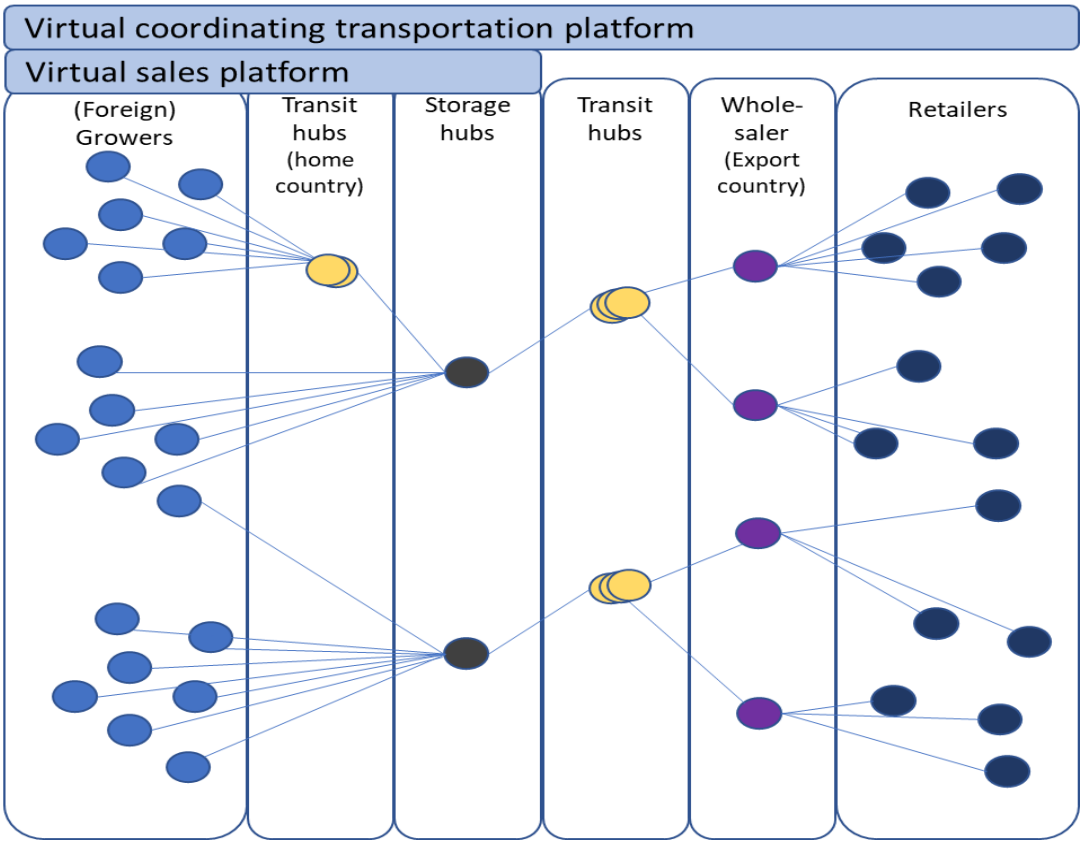


Figure 34, Optimal hub-network with an integrated virtual storage function

Figure 34 shows several transit hubs behind each other. This can be explained with an example. For example, when a grower from Kenya decides to send his products for sale to Europe, he will send it to a transit hub in Kenya before it is shipped to Europe. The product might arrive at a European transit hub before the still unsold product is sent to a storage hub. After the product is sold, it will be sorted per destination. To fill up a truck for the specific destination, the product might be sent to a transit hub in the same country to consolidate freight. In general, when products arrive at the country of destination they will normally arrive at another transit hub in the final country. From there on the product will be transported to a wholesaler or retailer in that country.

The transportation will be arranged via a transportation platform. On this platform logistics providers can sign in on transportation commands. Companies that can offer the best price or timing will get the job. In this way an open assignment system for every transportation company will be created and transportation can become more efficient. At this moment transportation is partly based on social structures where growers like to meet with customers and therefore drive to other locations. In this new idea of a transportation platform operating with supply and demand, this social aspect will become subordinate to transportation costs and efficiency.

A platform like this could grow from the collaboration of stakeholders in the floriculture chain. Stakeholders could react on the opportunity of combined cost reduction and efficiency. It could also be possible that another company or another market will start with a transportation platform and bring it into the floriculture market. Stakeholders might have different interests. A combination of various stakeholders with their interest could lead to different results.

The combination of Figure 33 and Figure 34 forms the future logistics design. The process flow of this design can be summarized in a flowchart. This flowchart is given in Figure 35. A larger picture is given in appendix A2.

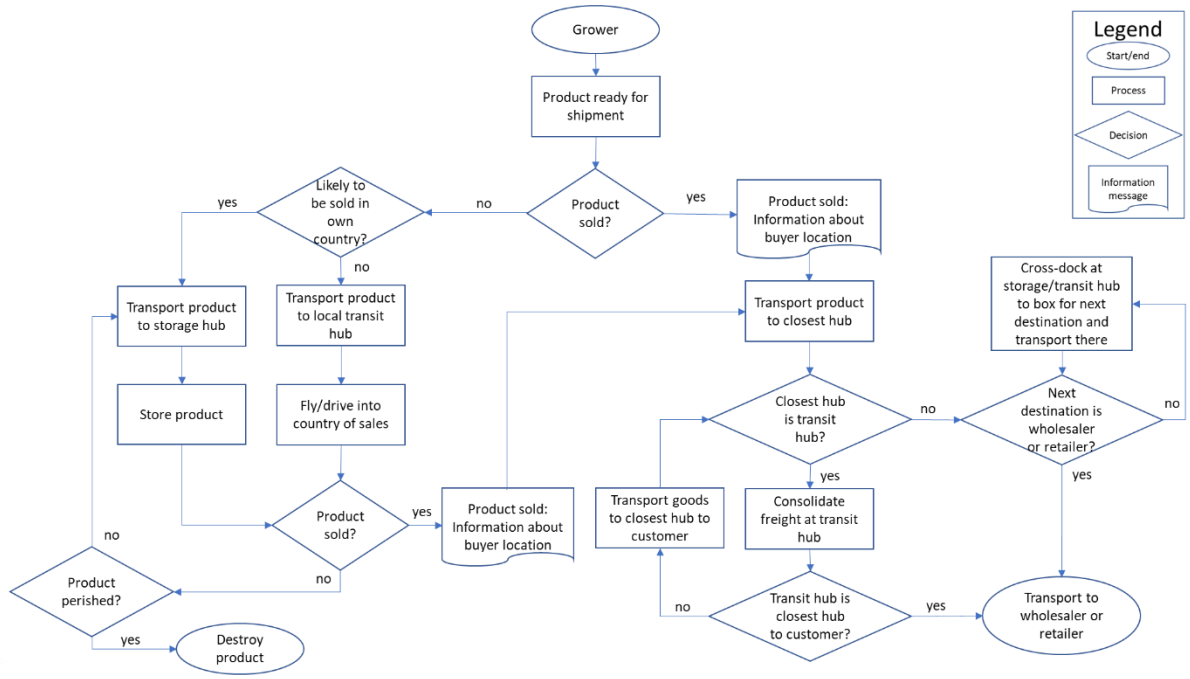


Figure 35, Flowchart final design: combination hub-network and virtual storage

In this flowchart products start at the growers, where they are being prepared for shipment. If the products are sold at the moment of shipment they will be brought to the closest hub location from where they will be transported in the most efficient way to the final customer, often a retailer or wholesaler. If the products are not sold, it will be determined in what country they are likely to be bought. Products are brought to a storage hub in the expected country where products will wait until they are sold. If product perish before they are sold, they will be destroyed.

Now the future logistics design is given, the most important question that arises is what the effects of this design are for the growers, the buyers and the auction houses. Those effects will be described in paragraph 6.2.

6.2 Design effects on key stakeholders

The resulting design of paragraph 6.1 will have its effects on key stakeholders in the chain. In this paragraph sub-question Q5b will be answered: *What are the effects of the design to the key stakeholders in the chain?*

Key stakeholders in the floriculture chain are the growers, the auction houses, the operators of the commercial and transportation platforms, the buyers from the auction house (wholesalers and retailers) and third party logistic companies. For all stakeholders this mid-term design will have effect on their daily activities.

Starting from the growers, nowadays, their daily activity is to transport their goods to the location where they expect to get the best price. When the virtual marketplace is running, pricing policies will change. Today's clock system can lead to large ad hoc price differences for the same products at the same quality between hubs in the same at country. These situational price differences will disappear and become more predictable for growers. New differentiated pricing policies will be developed per market, related to the market demand, quality and freshness of the products. The price will be influenced by demand from all over the world. This new sales manner will in all probability change the price per product. How prices will change is out of scope for this thesis and could be researched in another study. Next to this, the grower is responsible for a clear online profile per product he wants to sell. In this profile at least the location of the product, the type of product with specific

information, the freshness of the products and a picture of the product is needed. When one of those requirements is not fulfilled, the product will probably not be sold.

The auction houses will encounter a lot of change as well. Where they now facilitate in price formation, they will lose this task in the new design. Their role will change into a roll of controlling and checking goods on the right information and quality. The auction houses will in all probability turn into storage hubs. In those hubs the logistic function stays as important as the logistics in the auction houses are today. However, many investments are needed to transform the current locations into storage hubs. In a storage hub many products need to be stored in cooling cells and all trolleys of goods need to be independently approachable for order-picking. This requires large cooling areas. The locations of Royal FloraHolland are large enough for the first years to change into a storage hub, but the locations need to build more cooling space. This will give a lot of extra fixed and variable costs. Another difference for the flower auction will be that the distribution will need to be paperless in order to register everything in the system. As a consequence of cooled physical storage and virtual sales from the storage, the distribution will become more 24/7 instead of only on peak moments. Those two changes give enormous future possibilities for robotization. When the distribution times are more equalized over the days, it becomes more efficient to use robots instead of people for order picking and internal transportation, on the longer term.

New hub locations for transit hubs and some storage hubs in countries as Germany and Belgium need to be created. Royal FloraHolland could be the leading party in creating the physical hub locations all over the world. Stakeholders in the floriculture supply chain should look for common interests to cooperate towards cost reducing logistics. Royal FloraHolland could take the lead in the negotiation process with all stakeholders.

Another activity that needs to be managed in the final designed situation is the role of the operator of the commercial and transportation platforms. These new IT platforms are required to manage virtual storage, logistics, sales and financial processes. A requirement for this final design is that all movements of the product are followed by a transport management system that could calculate and steer on the most optimal routes. Another requirement is a sales platform on which all products are offered and price formation and the moment of sales take place. Those two systems need to be linked to each other since they both need information about the location of the product and the location of the buyer. The first system needs to calculate the most optimal routing towards the buyer and the second system needs to calculate the transportation costs for the buyer. It is likely that Royal FloraHolland will operate these platforms and take a key role for the whole supply chain, since they already took some steps towards a financial platform and a warehouse management system. Those systems need to be enlarged towards the whole supply chain in close collaboration with the growers.

For the buyers the largest change will be that they will not be buying at one location anymore but they will need to buy on a worldwide platform. For them the possibility to physically view the products before the moment of sales, will no longer exist. Because of this, the picture of the product provided by the grower needs to improve. In the new situation each buyer will be able to buy any product offered in the world. The system will then calculate the transportation costs per transaction, based on real transportation efforts. The buying strategy will depend on these costs, since some desirable product will come from further away and will have higher transportation costs. As a consequence, a better weighting between product quality and distance need to be made.

Last key stakeholder in the floriculture supply chain are the third party logistic companies. The main difference for them will be that driving distances become shorter, since they need to drive from hub to hub. Another difference is that because of consolidation the trucks will drive fuller, this causes longer unloading and offloading times.

Conclusion 6.2

In this paragraph, the main changes for the key stakeholders have been discussed. The discussed stakeholders are growers, the auction house, platform operators, buyers and third party logistic companies. Now question Q5b has been answered: *What are the effects of the design to the key stakeholders in the chain?* Important effects on stakeholders are implementation cost and effort. Next to this the online environments will change the activities and information flows of stakeholders. Information registration therefor will be more important in the new situation. New roles will become available in the design in for example operating the platforms. The online platforms will make the floriculture market and activities more international. Transport will become more efficient and driving distances become shorter.

An important next step for the final design is to check the design with the give requirements. This will be done in the next paragraph.

6.3 Future logistics design meeting the requirements

In order to finalize the future logistics design, it should be tested with the given requirements in chapter 4. During this paragraph the sub-question Q5c will be answered: *How does the final design meet the given requirements?*

For the final future logistics design, the two conceptual designs of virtual storage and a hub-network are combined. Since all trends that are incorporated per conceptual design, are still incorporated in the final design, it is viable to combine the yellow blocks of Table 10 and Table 11 into Table 12 for the final design. In this table it is visible that all fixed requirements of Royal FloraHolland concerning the researched trends (given with an asterisk) are met in the final design. Even more trends are included in the final design than required for Royal FloraHolland.

Table 12, Trends incorporated in future logistics design, the asterisk shows the requirement for final design

	Grower	Transport	Storage	Distribution/ processing	Customer	platform
2- years		Consolidation	Virtual storage function	Consolidation	Changing demand *	Online market place competition
	Collaboration	Increasing direct flow *				Virtualization *
2 - 5 years		Coordination *	Hub-network	Paperless distribution *	24/7 flower delivery *	Coordination *
5 - 10 years	Vertical farms, growing flowers in cities	Internet of Things platform		Smart robots		Blockchain
		Supply chain wide track&trace *				
10+ years			Cold chain, cooled storage through whole chain	Autonomous vehicles for distribution		
				Logistical blockchain		

Next to the researched trends, chapter 4 discussed the requirements and constraints to the new logistical model by Royal FloraHolland. Table 6 and Table 7 in chapter 4 showed the 'need-to-haves' and 'nice-to-haves' of the flower auction house. Those tables are repeated here to verify which constraints and requirements are met in the future logistics design. In the tables given below, the requirements are marked in green, orange and yellow. Green means that the requirements are met in the new mid-term design. Orange represents a development that is not integrated in the design. Lastly, yellow is an option that could be added to the design against extra effort and costs.

Table 13, Test of 'need-to-haves' with the final design

Product flow	Informational flow	Financial flow
Different flows	Handling of different types of information (products, flows, transaction types, etc.)	Virtual marketplace
Clear logistic actions	Track & trace of each trolley	
Increasing demand driven product flow (push to pull)	Knowing the status of each trolley	
Availability hub-locations	SLA being coupled to each transaction	
Paperless distribution	Coordination of flows and tasks	
Increasing direct flow	Virtual overview of logistic activities	
24/7 delivery	Information system to guide distribution	
	24/7 order intake	
	Ad hoc location assignment	

For the need-to-haves in Table 13 only the 24/7 delivery is marked in orange. Half of this requirement is met in the new design, namely the 24/7 distribution possibility can be met. Only the 24/7 delivery to the consumer is hard to arrange since retailers are still selling to consumers and they are not open 24/7. Whether a 24/7 delivery is actually demanded by consumers, has not been investigated in this study. The most important part of the requirement, a 24/7 running supply chain until the retailer can be met.

In this same table a requirement is set about the SLA of a product. The demanded arrival time of a product could be leading in some cases. It is not incorporated as integral part of the proposed design to add an SLA to each transaction. This option could be added to the total design or could be offered separately to some buyers who really depend on a specific SLA.

Table 14, Test of 'nice-to-haves' with the final design

Product flow	Informational flow	Financial flow
Automate break-bulk process	Completely specify the position of each product, even the position of each packaging on the trolley	Transactions via blockchain
Vertical farming	Internationalized information flow	
Consolidation of goods	Virtual platform for transportation	
Internationalized product flow		
Smart robots / AGVs		

From the nice-to-haves, Table 14, many requirements are also incorporated in the design. The only box marked orange, is for transactions via a financial blockchain. This financial blockchain will probably be technically possible on the mid-term, but since the floriculture market is not used to large changes, this development has been left out of the design for the mid-term. The idea of implementing blockchain into the floriculture market is still possible idea, at any time that the market is ready for it. Another research could be performed to find out about the possibility for using blockchain in this supply chain.

Three boxes are yellow in this overview of the nice-to-haves. As described in paragraph 6.2, it becomes possible to use robots on the hubs on the longer term. Robots could become effective since the operation will be more spread over the day, instead of the four-hour peak process of nowadays. Robotization will require a large investment for the operator of the hub. This investment could be earned back, since less people are needed in the operation, but it is not foreseen at the mid-term. Another yellow box is for the automation of the breakbulk process. In the new design the breakbulk process will completely change into order-picking. This process is quite similar to breakbulk. The

order-picking process could be automated and robotized, but this will require large investments as well.

The last yellow box is about vertical farming. This development is very well possible in the new design, but is not required for implementing the design. Furthermore, this vertical farming will probably not be started by one of the key players in the supply chain. It is more likely that another party will start a vertical farm and will connect it to the hub-network before the year 2025.

Further elaboration on the colors in the tables and how the requirements and constraints meet the final design will be done in the evaluation in chapter 8.

Conclusion 6.3
Answering Q5c (*How does the final design meet the given requirements?)* can be said that almost all requirements are met in the new design. Requirements that are not met could be integrated in the design by investing extra money.
The steps towards this new design will be elaborated in the paragraph about directions for the implementation of the design.

Conclusion 6
The two solution directions that are turned into conceptual designs in chapter 5 have been combined into a future logistics design in chapter 6. During this chapter the sub-question Q5 has been answered: *How can the chosen solution directions be combined into a final design and how to migrate from the current situation towards the designed situation?*

At the start of chapter 6 has been elaborated on a logistical design that combines the virtual storage function with a hub-network. This resulted into a future logistics design that meets almost all fixed and desired requirements. The design will have its effect on the stakeholders in the chain. Many stakeholders will run into extra implementation costs and manners need to change.

7 Implementation directions

The very last step for the future logistics design is to compare the current situation with the situation in the new design. When those situations are clear, directions for implementation can be given. In this paragraph question Q5d will be answered: *What are the differences and similarities between the current situation and the operation in 2025 and what implementation steps are needed?*

The goal of these implementation directions is to be able to change the complex floriculture market into the described design within the next 7 to 8 years until 2025. Nowadays most parties in the chain are only thinking about their own business instead of the whole chain. This needs to change to make a transition to the new logistical design. In order to reach this goal stakeholders in the floriculture chain should collaborate to find their common interests and benefits. Royal FloraHolland could take the lead by starting a strategic team that will be responsible for the elaboration of the design and business case, the stakeholder alignment and a smoothly running information network.

In the current situation the growers are organized into the flower auction Royal FloraHolland. This makes this auction the largest party in the floriculture chain. Royal FloraHolland gives the growers the opportunity to sell their products. The main roles of Royal FloraHolland are price formation and logistics, but advertising and market research are part of their role as well. Logistically seen, Royal FloraHolland needs to change its locations to be ready for a large, cooled, storage function where products are separately approachable. This change towards the first storage hub initiates the change of the market towards the final design. Expansion of the cooling area for storage at the Royal FloraHolland locations need to be realised in within the first years.

Thereafter the number of hubs need to be expanded to create a network. The designed concept will only work properly when a large network of storage and transit hubs has been realized. In order to get there, transit hubs need to be built. Those hubs need to be close to highways and should be able to process all products within one hour. A small cooled storage needs the be at every transit hub to store products until a truck can be fully filled up. Deliberation is needed with parties in each hub country where the hubs can be positioned. Royal FloraHolland and transport/export companies need to collaborate in the construction of those hub locations. Conversations and negotiations about this matter need to start immediately, to start the construction of the locations within the next two years. For some transit hub locations an existing building can be used that need to be revamped. For other locations new buildings need to be constructed. This construction period will take a lot of time and after the negotiation time this will be one of the critical paths during the realisation of the design. Investments need to come from transportation companies, TLN, Royal FloraHolland and with support from governmental organisations. Since this design will support more efficient and sustainable transportation, subsidies could be asked from ministries and logistics support groups.

In order to create an overviewing coordinating platform, for transportation between the hub and other parties, a lot of information is needed. A format needs to be created for every grower in which they can register a product and connect it to a packaging. Every packaging needs to be equipped with a bar code or tracking device in order to keep track of every product throughout the supply chain. At every step in the chain each product needs to be scanned to keep the platform informed about the location of the product. Next to information about the product, the platform needs information about transporting trucks and airplanes. This information is required for the system in order to be able to calculate optimal routings and transportation costs. Each third party logistic operator can be able sign in to the system and give the availability of its trucks. A platform like this should be created for the floriculture market or can be bought from another market. In the first case it will take the full 7 to 8 years to make it operational, but it will fit the market perfectly. In the second case it will be easier to get a transport management system operational on the mid-term, but it will not be completely custom made for floriculture.

This system needs to be closely connected to the financial platform. In this financial system the status of each product needs to be clear. In this system every floriculture product will be offered for sale. The price per product will depend on the quality of the good, the demand from the market and in addition the transportation costs to the final destination. To calculate the transportation costs, this system needs to work closely together with the transport system since data about location and routing are coming from this system and are important to calculate transport prices. The financial system communicates to the transport management system about which products are sold to which customer. When this is done, the transport system can arrange the routing and transportation of the product.

Ownership of those two systems is likely to be with Royal FloraHolland. This company is already leading in the chain and has a lot of historic data and stakeholder connections that could be used in those two systems. A financial platform is already in use by Royal FloraHolland and only needs to be expanded and connected to a transport platform. First Royal FloraHolland needs to contact other parties in the chain to create a plan for how all products will be tracked through the chain until the wholesaler or retailer. Subsequently the financial platform needs to be prepared to handle all transactions in the chain. When products start to perish, algorithms in the platform can propose to discount the product prices. These changes in tasks will cost a lot of time and money to implement, so Royal FloraHolland has to start urgently with upgrading the current platform or acquiring other parties to improve the platform. The platforms do not only require investments, money can also be earned back since the platforms serves the complete information flow through the whole supply chain and all stakeholders will use it and need to pay a fee for it.

Since the new way of working will be completely paperless and the platforms needs to keep track of every step of each product, many more scanners, induction loops or IoT technology is needed to make this design possible. At every stage in the supply chain a scanning method will be needed. Growers need to be able to scan or register each product, first on the garden to offer it for sale, and later when the product leaves the growers' location. Growers need to invest in those technologies. Furthermore, on each storage hub at least three contact moments with the system are needed, with the intake of the product, the moment of sales to take the product out of storage and at the outtake. For those contact moments technology is needed. Next to this, every storage hub has to have some kind of warehouse management system to register a where product is stored and to steer on order-picking. This system can be bought centrally or per separate hub. Transit hubs also need tracking and scanning technology to take in and out products. And lastly, it should be exactly clear which products are transported by which truck. Ideally the trucks will all be equipped with a GPS tracker to follow each product.

The implementation directions described do not have many mutual dependencies. The implementation steps can be taken in parallel. Therefore it is not useful to create an overall implementation planning. The downside of this fact is that a lot of things need to change at the same time which requires a lot of trust in each party. Every party needs to invest a lot of money to create this new logistic design. However, when only a few steps are taken and others are not, the design will not work properly. Each party needs to change according to clear agreements.

Conclusion

In this paragraph the most important steps towards a successful implementation of the logistic design for the floriculture market have been described. The sub-question Q5d (*What are the differences and similarities between the current situation and the operation in 2025 and what implementation steps are needed?)* can be answered now.

Most important difference between the current situation and the future situation in the floriculture market is that all parties in the chain need to communicate and collaborate more than they do now. For this an overarching team with members from each party in the chain, needs to be formed to initiate and control the transition towards the new design.

Functional implementation steps that are needed towards the new situation are:

- to create or change hubs into storage hubs and transit hubs to build a strong distribution network;
- to implement two supply chainwide IT-platforms: one logistic platform and one sales platform that communicate with each other and are able to oversee the whole chain;
- to acquire enough scanning and tracking technology and equipment, to support the platform with the needed information.

For the implementation towards the new design many steps need to be taken, but with an overarching team of implementation professionals this design could be feasible on the mid-term. A notable part of the implementation is that not many steps need to be taken sequentially. This means that with a lot of parallel steps, the difference can be made in a few years.

8 Evaluation, discussion and recommendations

In chapter 8 the evaluation and results of the final design will be evaluated in paragraph 8.1. In this paragraph the main objective of the thesis will be concluded as well. In paragraph 8.2, the discussion, will be described what the limitations and the successes of this research were. In paragraph 8.3 recommendations for a next research and for the flower auction house will be given.

8.1 Evaluation

In this paragraph firstly the final logistic design will be evaluated and compared to the constraints ant requirements set in chapter 4. In this evaluation the expectations and the risks of the design are described. In the second part of this paragraph the conclusion to the main objective of this research will be given.

8.1.1 Evaluation of final future logistics design

In the trend analysis in part A the Gartner hype cycle of the floriculture chain showed that the maturity level of each trend differs. For a mid-term design, all trends that are mature within about 7 years could be incorporated. From all trends that are required for the two conceptual designs, so for the future logistics design as well, only the supply chain wide track & trace function is expected to be market mature between 5 and 10 years. This might be a critical point for applying the future logistics design on the mid-term. A simplified track & trace system should be used in the start-up phase of the design. In the next years the tracking and tracing will be improved together with the used technologies. This track & trace system is directly coupled to the logistics and sales platforms. Those platforms will need suitable workarounds until a supply chain wide tracking system will be market mature.

In the trend and development analysis many operational and technological trends have been discussed. Some trends like logistical and financial blockchain technology, Internet of Things and the cold chain could cause more rigorous changes to the supply chain than other trends. However, since this report focussed on the mid-term, those changes are too immature to fully incorporate in the mid-term design. This resulted in a final design for the logistics on the mid-term that has been built up from mostly ‘basic’ technology choices. The innovative part of the final design is the use of the online platforms and the combination of trends that will change the structure and culture of the chain.

The final future logistic design consists of a combination of two conceptual designs for logistics. One part is a virtual storage function and one part a hub-network. The concept of the virtual storage is commercially based on selling products located at any location between the garden and a hub-location. This concept supports a more demand based and effective logistics, since the transportation routing could be changed whenever the products are sold. A hub-network was designed that is based on the combination between storing of unsold products and distribution of sold products. Special hubs will be created that will have a physical storage function and other hubs have the main task to cross-dock goods and consolidate product flows. This logistical design should make the whole supply chain more efficient and sustainable.

In the final logistic design the two conceptual designs have been combined where they seamlessly complement each other, since both conceptual designs operate on different levels. The concept of virtual storage operates between commercial and logistical supportive level. Track & trace technology and a transportation platform support the commercial opportunity of selling products wherever they are. The information flow is extremely important for this concept. For the other described concept, a hub-network, the physical flow is more important. This concept makes it possible to consolidate flows and make the supply chain more sustainable. Both concepts can exist at the same time and are taken together towards a more optimal floriculture logistics.

Now the final logistic design has been evaluated, all given requirements and constraints for this project are tested to the future floriculture logistic design. In Table 15 all given requirements and constraints are given and the fulfilment in the final design is described. The last column shows with a colour whether the requirement has been met by the future final design.

Table 15, Design requirements and constraints compared to final design

Requirement/constraint	Fulfilled in final design	
Different flows	Different type of flows (direct, order-picking, cross-docking, different temperatures) are possible.	
Clear logistic actions	In the new design a transportation platform and a sales platform are closely cooperating to create clear logistic actions.	
Increasing demand driven product flow (push to pull)	The virtual storage function makes the supply chain more demand driven, demand based logistics can be performed.	
Availability hub-locations	Second part of the future logistics design described the hub-network.	
Paperless distribution	To be able to create an optimal working information environment for the transportation and sales platform an online and paperless information stream needs to be created.	
Increasing direct flow	Since the direct flow from grower to consumer is not included in this future logistics design, it is no constraint for the design. The direct flow could increase without major effects on the described logistics. Direct flows could make use of the new transportation platform.	
24/7 delivery	Where 24/7 order possibilities are becoming normal with an online sales platform, the 24/7 or just in time delivery is a logistics purpose that requires a lot of effort. This future design is based on a more demand driven chain, however, it is not ready for a 24/7 delivery concept to all customers.	
Automated break-bulk process	A fully automated break-bulk process according to Gartner is not feasible on the mid-term. However this design does not have any constraints of implementing this automated process if available.	
Vertical farming	Vertical farms are not needed for the implementation of this design. Stakeholders can start their vertical farms and connect it to the design.	
Consolidation of goods	The hub-network in the final design is based on the consolidation of the flow of goods through the chain.	
Internationalized product flow	With international hubs, growers and customers the design will automatically be applicable internationally.	
Smart robots / AGVs	Smart robots and AGVs are of high costs and are not required for the final design. If time and money are available they can be incorporated in the final logistics design on the hub-locations.	
Handling of different types of information (products, flows, transaction types, etc.)	The information platforms should be able to handle all types of product and transaction information. Hubs in the new design should be able to handle all kinds of product flows.	
Track & trace of each trolley	In the new design trolleys can be tracked through the supply chain. At the implementation phase tracking will be at certain points in the chain, later it will be feasible to track them real-time.	
Knowing the status of each trolley	With the sales platform the sales status of each trolley will be visible real-time.	

SLA being coupled to each transaction	With detailed transaction information it would be possible for a buyer to ask for a specific SLA. However, more quantitative data will be needed to find out which SLAs are feasible per product flow and type.	
Coordination of flows and tasks	With the sales platform and transportation platform the logistics of product flows can be coordinated.	
Virtual overview of logistic activities	On the transportation platform all logistic activities of the products outside the hub-locations will be visible.	
Information system to guide distribution	On the hub-locations a warehouse management system should lead logistics.	
24/7 order intake	With a virtual storage concept products can be ordered at any time of the day. Hub-locations need to adjust on this to spread out their logistic actions over the day.	
Ad hoc location assignment	Since products can be sold at any moment and any location in the chain with virtual storage, a logistical command for location assignment should be given ad hoc	
Completely specify the position of each product, even the position of each packaging on the trolley	In order to make the virtual storage work, the location of every product needs to be known. A collaborating system for transportation and internal logistics should support this.	
Internationalized information flow	The information flow should be going through the entire chain. Since many growers and buyers are located in various countries, those information flows need to be international and virtual.	
Virtual platform for transportation	The described transportation platform.	
Virtual marketplace	The described sales platform.	
Transactions via blockchain	The blockchain technology appeared to be too farfetched for this design. Besides this, it is not core business of logistics.	

According to Table 15 most requirements are met in the final design. From the fixed requirements only 24/7 delivery and the coupling of a demanded SLA to each transaction are not completely met. 24/7 delivery is partly met with the more just in time delivery of the new design. The question whether the market demands a real 24/7 delivery is still open. In further discussion with Royal FloraHolland and other stakeholders need to be decided how this will be dealt with.

A notable risk for the new logistic design is the drastic impact it will have on the entire supply chain. The impact will be visible in finances, culture, time to spent into the transition, and the way of working needs to change. As discussed in chapter 6, all stakeholders need to trust each other on the amount of effort and financial resources they put into the change towards the new design. If one party fails to meet the agreements, realization of the design cannot be achieved.

Flower auction house Royal FloraHolland envisioned logistic changes in their 2020 vision and needs to development a logistical vision for the longer term to maintain in leading position in the floriculture supply chain. It is to their interest to keep other stakeholders aligned for the transition towards a new logistical design. This transition could be initiated by a strategic division of the flower auction house, but they will need many other stakeholders to eventually realize this future vision.

The future floriculture logistic design will have impact on all stakeholders in the analysed part of the supply chain. All stakeholders will have their own opinion about the design and they will deal with different consequences. Although, according to all analysis, it might be feasible to realize the future logistics design on the mid-term, it will not be easy. Many stakeholders need to be involved in the

changes which might lead to incomprehension. It could take some time to get everyone aligned on the steps to take towards a better logistics in the floriculture market. This might shift the expected implementation time towards the longer term. Complex projects of this size require a lot of resources and effort the make the project successful.

8.1.2 Conclusion main objective

After the evaluation of the future logistics design the main objective of this research can be concluded:

To develop a feasible logistic design for the flower auction Royal FloraHolland for the year 2025, based on the maturity of technologies and trends in the floriculture market.

During this report many steps have been taken towards a final, future logistics design shown in chapter 6. Testing the future logistics design to the trend analysis and given requirements in part A, the developed design might very well be feasible for the mid-term time span.

As described in the evaluation the only concern about the implementation of the logistic design within the mid-term time span is to get all parties aligned. They all need to invest a lot of money and need to make rigorous changes, but they need to do it at the same time to be able the change the entire chain. To do so, they all need to have the financial resources available and they need to trust each other that every stakeholder will make the necessary changes. The question is whether they are all ready for the change and have the resources to change to make this logistical design feasible on the mid-term.

8.2 Discussion

In this research project many successes have been accomplished. Those successes are described in paragraph 8.2.1. In the next paragraph the limitations of the research are given.

8.2.1 Success of this master thesis

In this report a conceptual research for trends and developments have been performed for the long term that could be applied on the floriculture market. These trends and developments have been analysed on their maturity level, time to market and their mutual relationship. By plotting all trends on a hype cycle the feasibility of trends became clearer. This scientific long-term research leads to more operational mid-term designs. Those designs can be very useful for the described parties in the supply chain and can be used as a starting point for further evaluation and simulation.

The final design, the future floriculture logistic design, is a success since two market improving conceptual designs have been combined towards one final design. Both designs already added market value, and the only support each other when they are combined into one final design.

The concluding logistics design will be a success when all stakeholders in the first part of the supply chain will collaborate to make the changes towards this design possible. Further research into the detailed implementation steps and the business plan are needed before the design can be successfully implemented.

8.2.2 Limitations for this master thesis

For this thesis, many different trends have been described. With this selection of trends a fairly complete overview of technological influences on the future floriculture logistics has been sketched. However, it is not possible to predict all future influences, so this overview cannot be considered as complete until the year 2025. Most important influencing trends are considered to be taken into account.

The floriculture market is a very specific market where not much research has been performed. Most research on the market comes from Royal FloraHolland and the DaVinc3i project. This made it hard sometimes to underpin certain arguments and the completeness of the trend analysis. Main difference of the floriculture market compared to other supply chains is that this chain needs to deal with perishable products. This has its consequences that are specific for this chain and for food chains. More literature has been found about food supply chains. Throughout this research, some articles are used from the food chains, but more research is needed to find out about comparisons between those chains.

Since there is not much literature available about the floriculture market, many articles and presentations from within Royal FloraHolland are used for this thesis. Next to this some literature is even created together with Royal FloraHolland. This means that many references and literature used are based on the visions, researches and opinions of only one key stakeholder in the supply chain. This could also be a limitation of this research.

In the last chapter, implementation directions, has been described how collaboration of all stakeholders will be a limitation in implementing the final logistics design. The final design includes so many aspects that it will need a lot of guidance and collaboration to be fulfilled. The goal to implement this future logistic design in the floriculture market before 2025 could therefore be somewhat optimistic.

Maturity levels of trends and developments have been analysed. However, it is already hard to conclude the right expectations for market maturity of those trends on any market, let alone to make credible conclusions for the complex floriculture market. This means that the discussed floriculture hype cycle can only be used as a guideline for the market, but not as fixed expectations.

8.3 Recommendations

After this research a few recommendations can be done. First recommendations for further academic research will be given. Secondly the recommendations for the auction house will be described.

8.3.1 Recommendations for further research

During documentation of this research already a few recommendations for new research have been done. In this paragraph recommendations will be described, some of them were already described throughout the chapters, others are new.

In this research the scope of the research had been until the buyers of the flower auction house, the retailers and wholesalers. This meant that sales strategies towards the consumers were out of scope. It is assumed that consumers will ventilate their opinion through the supply chain via the retailers. In a new research it is recommended to perform further research on the opinions and demands of the flower consumers. This could be tested against the opinions that the retailers and wholesalers bring into the supply chain. In a longer term it might even be possible that retailers and wholesalers will not exist anymore and every good will be sold via an online platform directly from the grower to the consumer. In this case the opinion of the consumer will be even more important.

As a result of this, a large flow in the floriculture market, the flow from grower directly to the retailers or consumers, has not been described in detail. This direct flow is increasing over the last years and is expected to increase in the following years (Stubbé, 2016). In further research can be analysed whether this direct flow can be incorporated in the developed future logistic design of this report, or whether a new or complementary design is needed for this flow.

Another recommendation is to perform more research about the physical internet and the applications of hub-networks in other markets. For example the package delivery services already have hub-networks to bring the packages as fast or cheap as possible to the customer. They can differentiate the price according to the customers' demand.

For the elaboration on a hub-network in this report, the EU floriculture market has been taken as a starting point with a main focus on the Netherlands. In another research one of the other markets mentioned in the world floriculture map could be taken as a starting position for research.

A last recommendation for further research is to perform more research on the possibilities for using both the financial and the logistical blockchain in the floriculture supply chain. The application for using blockchain in combination with the two proposed platforms, for sales and logistics, might as well be more researched.

8.3.2 Recommendations for the flower auction house

Next to the recommendations for new academic research, there are also recommendations for the flower auction house Royal FloraHolland.

At this moment the final design is on a quite conceptual level. In order to go towards implementation of this design in the supply chain a more detailed design needs to be developed for operations and about the information flows and platforms. A more quantitative model of the design is needed. This model will support the business case for the design.

It is recommended for Royal FloraHolland to stay in charge of creating the financial and logistical platform. In this way the company stays unmissable in the supply chain and will keep its value propositions for many more years. This development of those platforms need to happen on the very short term to prevent competitors from creating this platform before Royal FloraHolland can do it.

Towards the future Royal FloraHolland needs to think of the picture for the future and which role it wants to have in this picture. The flower auction house could start the conversation with important stakeholders as growers, transporters and wholesalers to find out the different interests. All stakeholders need to think about their new role in the market. Stakeholders should respect each other's interests and use all value adding activities to create an efficient environment in which all stakeholders want to operate.

A last recommendation for Royal FloraHolland is to keep up with technology changes and to keep informed about developments in for example blockchain and cold chain technologies. Those technologies are suitable for a logistic vision for the longer term.

9 Reflexion

This thesis towards a future design for the logistics at the B2B side of the floriculture supply chain has been interesting and challenging. A complex market as the floriculture market is a very interesting position for a redesign. This resulted in some good things and some difficulties during the project.

One of the challenges during the project was to find the real client need and the scoping of this need. Scoping of the projects took a lot of time and had to be redone many times. Even the decision of describing two conceptual designs instead of one or more resulted in a scoping issue. The final scope twist happened in the last weeks of this thesis.

In this thesis, scientific research has been performed on trends and analyses in the floriculture market and in other markets. Those trends are collected from many different sources, however, this list cannot be considered as complete. The analysis of the trends has been done with various methods, using many sources and brainstorm sessions with people from Royal FloraHolland. For this research the results are considered as enough. However, the exact positioning of some points and the expectations about exact dates could be different in other research performed with different people and opinions.

According to a derivative of the Dym and Little methodology this is used to form the problem definition. With this, in combination with the set requirements, the design phase started. In the design phase the first steps towards a detailed design have been taken. This research finished with the future logistic design, which is comparable to a preliminary design, which is one step deeper than only a conceptual design. Directions for implementation have been described for this design which could help in the final implementation. To get there, more research is needed into detailed implementation steps, costs and benefits.

This project has been a likable combination between literature research, conceptual designing and rationalization. The combination of those elements kept the entire research interesting. The structure of the Dym and Little methodology was a good base for this research and could easily be adjusted to fulfil a well supporting role in this research.

This project was performed during my internship at Royal FloraHolland. During the process my supervisor left the company, so I had to change supervisor and talk him into my project. This eventually did not cause many problems. More challenging was the stage of change of the company in which I entered. During the process of writing my thesis, many projects and teams changed within Royal FloraHolland, which gave different insights and caused that I had to rewrite some parts of the thesis. Since I was able to focus on many things at the same time, it was easier to fulfil my thesis. Next to the focus on my thesis I got the opportunity to work on a project at Royal FloraHolland linking IT and logistics. Besides this, I am playing top sports, field hockey, for which I have to train almost every day a few times. This brought me the right relaxation and a good variety between studying and sporting.

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Appendix

A1 Interviews

Vision 2030 floriculture supply chain
Participant: Rolien Wiersinga - Program manager FLOW, colleague Edwin Wenink
Date: 24-04-2017
Subject: Vision 2030 floriculture supply chain

The developments in the floriculture supply chain are initiated by trends of this moment. Most important trends influencing logistics that can be recognized are the autonomous economy and changes of consumer behavior. The effects of an autonomous economy are recognized in the synchro modality in logistics and a different way of delivery of products. Instead of delivery with trucks only, innovative ways of self-driving vehicles and usage of personal cars will grow. Next to this the consumer is changing towards a more individual living person in the city, where they increasingly expect to have orders on demand. This means for the floriculture supply chain that the chain will change towards a more demand driven chain compared to the supply driven chain at this moment since consumers will increasingly determine what happens in the chain.

Rolien describes a 2030 future situation of the flower auction house as a more facilitating role. This facilitating will be done by digitally coupling financial, informational and logistic services (assets). Next to the price formation facility the auction house will facilitate a demand driven chain. The chain will not be shortened, but communication networks will be shorter and faster.

Other options for the future of the flower auction house are to generate a central warehousing concept with various hubs. Or to facilitate a conditioned supply chain in which the temperature and humidity can remain constant to keep the floriculture in good condition for a longer time, this is an important boundary condition for the future supply chain

Those options are derived from the fact that the market becomes more demand driven. Transactions will be more and more fine grained. Next to this both growers and customers only want to pay for services that they actually use, instead of paying for the total package. This means a more demand driven way of thinking for the auction house both towards the growers and the customers is required.

New technologies will be tried and used by the auction house. Internet of things will become more mature. This is already tested with the LoRa technology of KPN to perform track&trace on logistic means. A new packaging 588 is developed in which the IoT principle could be applied. Besides this block chain could be used in the supply chain, particular with respect to supply chain finance.

Blockchain applications for the floriculture supply chain
Participant: Zeki Erkin – TU Delft
Date: 02-05-2017
Subject: Blockchain applications

Blockchain is seen to be used in three cases. First case is to make faster payment feasible. Second case is to give small and medium enterprises the possibility to get money easier. Third case is about the circular economy.

Carrier can be payed directly after transportation is completed. This saves the large delay in time. Next to this third parties as banks can be replaced by blockchain by writing a smart contract that will be triggered as soon as product is delivered. After this trigger the carrier will be paid immediately, which saves a lot of time and is good for the economy.

Small and medium enterprises need financial security. Since they are small, banks do not give them enough credit. In blockchain the number of products in the warehouse and the value can be registered which serves as prove to get money from the bank. In this case the bank is still important, but it will be easier to get money.

Circular economy. If a box is owned by a company and will return to the company, it will not be seen as waste. This will reduce costs and help the environment. Boxes need to be tracked throughout Europe (smart trash bins) to bring boxes back to the company. This principle is important and needed since resources are scarce.

Blockchain can be used to remove paper contracts, since transactions are secure and happen directly after the transaction is made. Blockchain provides prove and security in financial transactions. This could create more collaboration and trust among parties that do not know each other and each other's background, which makes it easier to trade.

With blockchain the single point of trust is replaced. Smart contracts can be set up for immediate payment which make those points of trust unnecessary. Smart contracts in this way provide more security and transparency to the market.

Digital strategy
Participant: Remco Wilting – Manager Digital Strategy Royal FloraHolland
Date: 03-05-2017
Subject: Digital strategy Royal FloraHolland

Flowers and plants are physical products and the flower auction is a market place for those products. This market place provides different ways to form a transaction. At this moment the main transaction options are via the clock auction or direct sales. In the future more transaction possibilities will be available. This will be possible via an online platform operated by the Dutch flower auction of Royal FloraHolland.

This online transaction platform will facilitate the worldwide floriculture market. It connects growers and customers and will give more options to both parties. Transactions on this platform will lead to a command for distribution. As a result, distribution can be seen as a connecting service. Both the auction house as third parties can have an important role in performing those services. This online platform will serve as a market place where growers can upload advertisements for their products and where buyers can watch the product and select their optimal way of buying. In the future it will be possible for growers to sell their products when they are still growing or bring it to a central place for cooled storage. Next to this many different types of auctioning and selling will be available which introduces a larger freedom of choice. The flower auction house can advise growers and buyers on their choices, but the market will eventually determine best practice.

Since the floriculture products are physical products, a distribution component as a service to the online platform will still be needed in the future. However, the Netherlands will not necessarily stay the main hub in the transportation of flowers and plants. Goods from various continents will be transported to buyers in a smarter way.

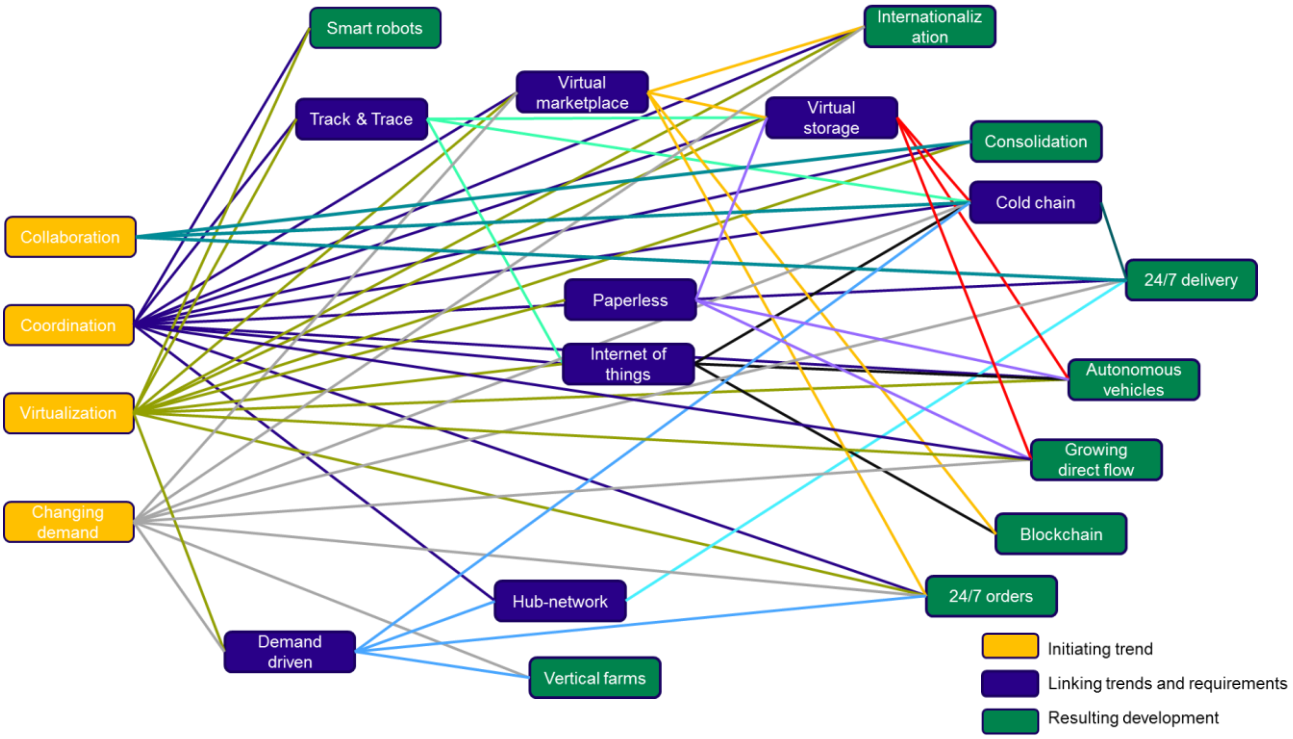
In the future Royal FloraHolland will provide this online platform. The main advantage of the cooperation is that they will have all the market data and will be able to set worldwide standards for the floriculture market. This makes the auction house unavoidable. Next to this Royal FloraHolland has the choice of performing one of the logistic services that will be needed in the market. It is important to keep activities where you are good at. An example of such a service could be the distribution of packaging from trolleys or a storage function on various hubs. This storage function is interesting for growers with large peak moments. Another trend that attaches to this subject is growing of flowers and plants with artificial surroundings in a flat building in a city. This already creates an important hub-location and decreases the need for distribution at the side of the grower. Distribution operates within a network and hubs could help to optimize those networks from growers to end users.

Vision and practices Let it Grow
Participant: Madelon van de Ven – Manager communications Let it Grow
Date: 19-05-2017
Subject: Vision and practices of strategic program 'Let it Grow' of Royal FloraHolland

'Let it Grow' has started as one of the strategic programs within Royal FloraHolland. It is a project that tries to connect the changing supply and demand in floriculture sector. At the demand side 'Let it Grow' tries to influence experience, inspiration and buying behavior of the customer and at the supply side it tries to help the grower to adjust to the new demand. Since an increasing amount of people will be living in the cities their needs are changing. Products need to be more practical and possible to place on a small balcony or house.

'Let it Grow' tries to connect the old world, the floriculture sector, to the new world of startups, quick market changes and changes in demand. Companies with new concepts as Bloomon are changing the market. Royal FloraHolland can stay an important information and physical hub as the basis for new (digital) activities.

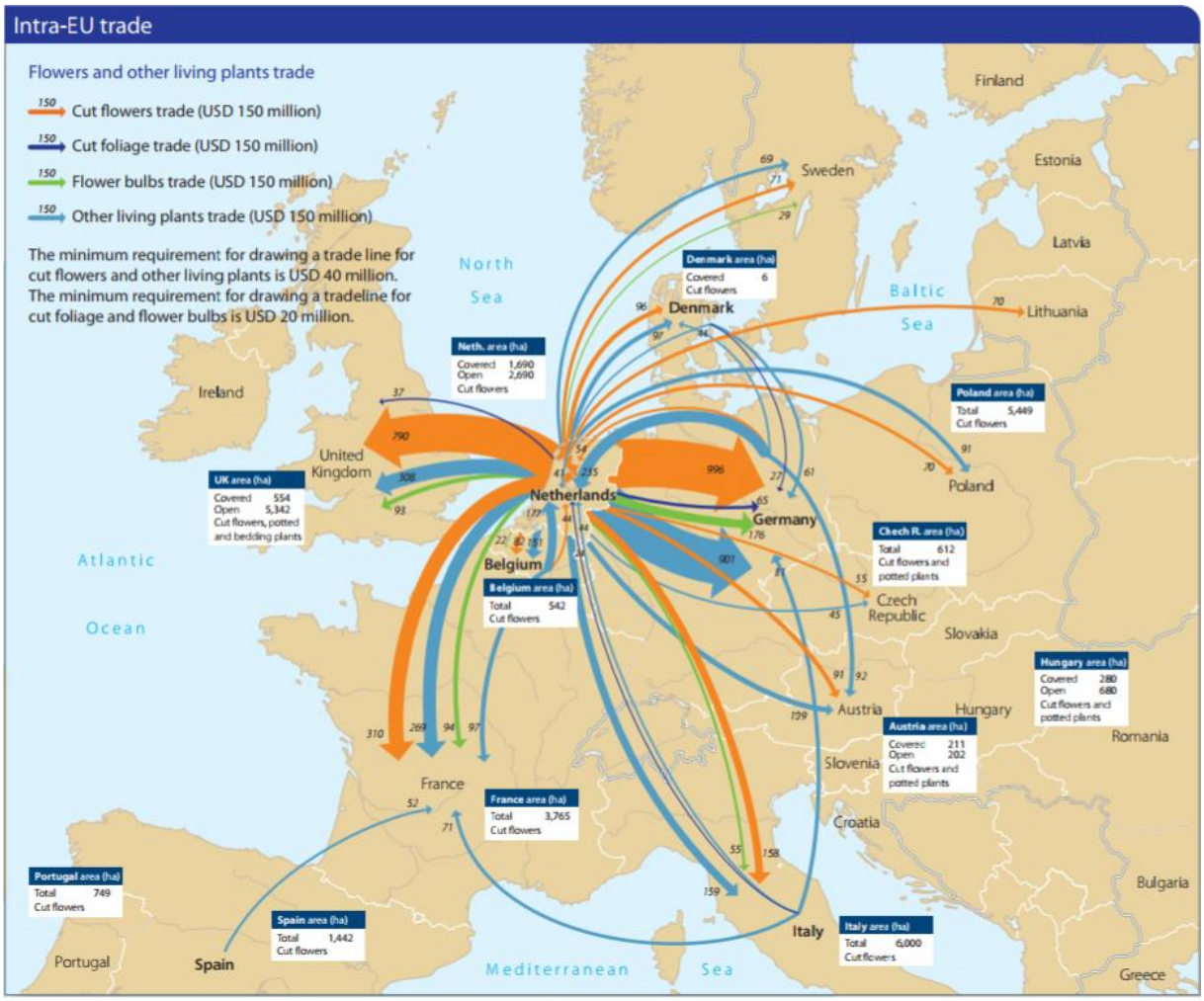
A2 Complete pictures and value adding figures



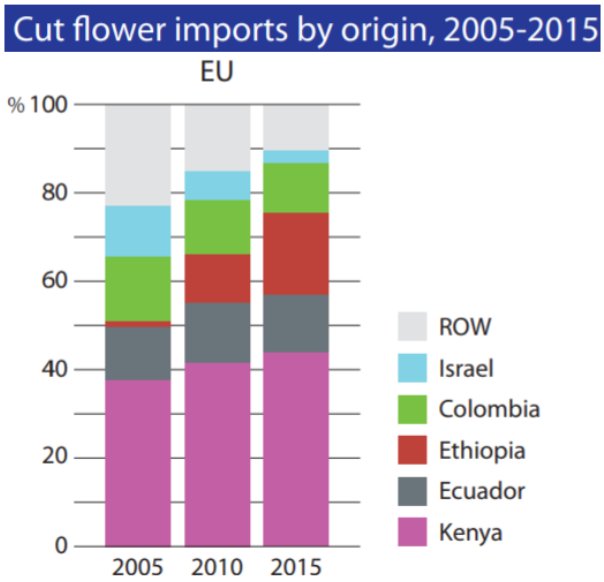
Appendix figure 1, Complete overview dependency diagram of requirements

Requirement/desire	Goal	coordination	virtualization	changing demand	collaboration	hub-network	virtual storage	Track&Trace	IoT	virtual marketplace	paperless	demand-driven	cold chain	24/7 orders	blockchain	consolidation	internationalization	autonomous vehicles	smart robots	vertical farms	24/7 delivery	growing direct flow
coordination																						
virtualization																						
changing demand																						
collaboration																						
hub-network																						
virtual storage																						
Track&Trace																						
IoT																						
virtual marketplace																						
paperless																						
demand-driven																						
cold chain																						

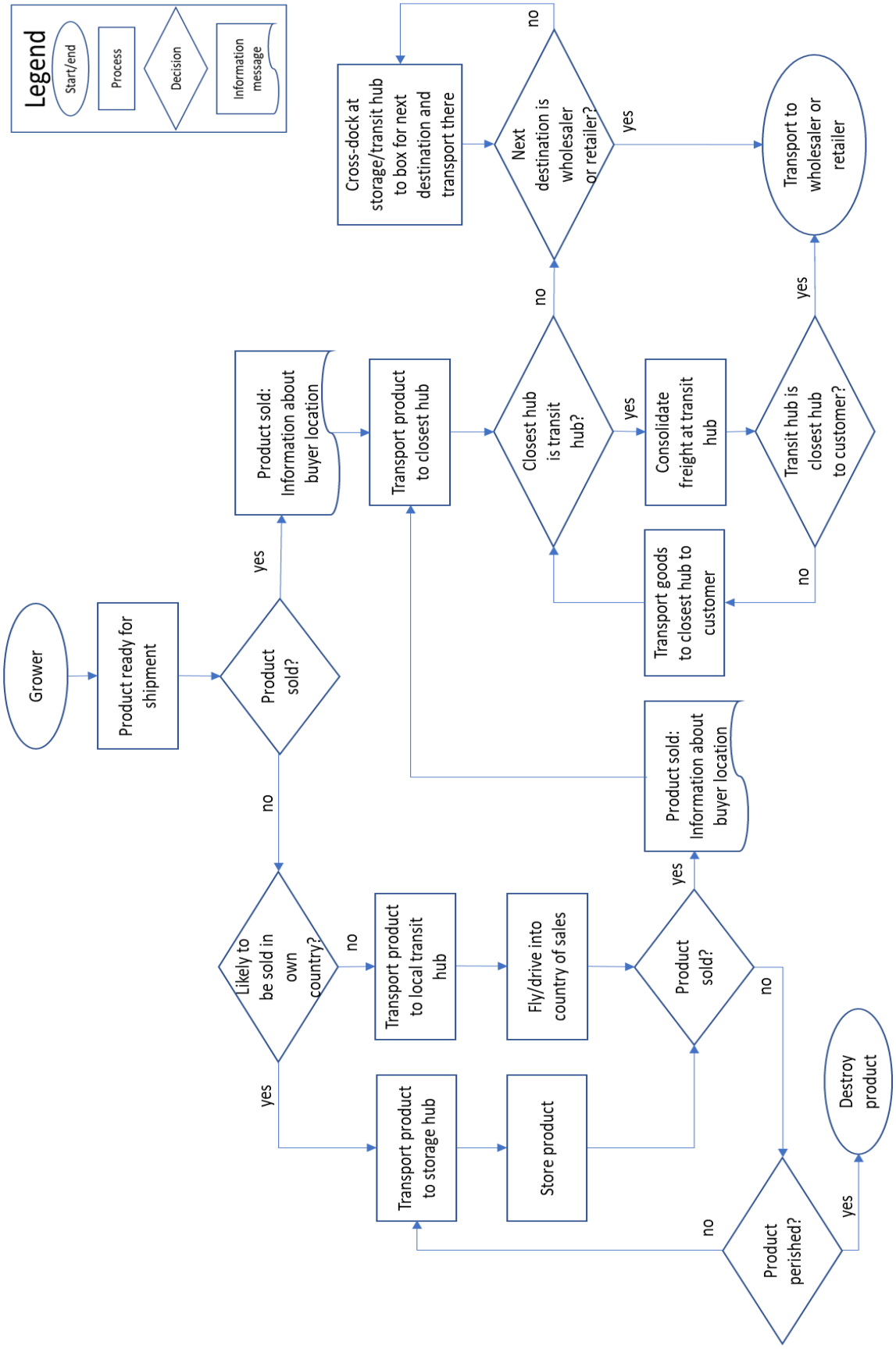
Appendix figure 2, Relationship analysis with colours showing initiating, linking and resulting trends



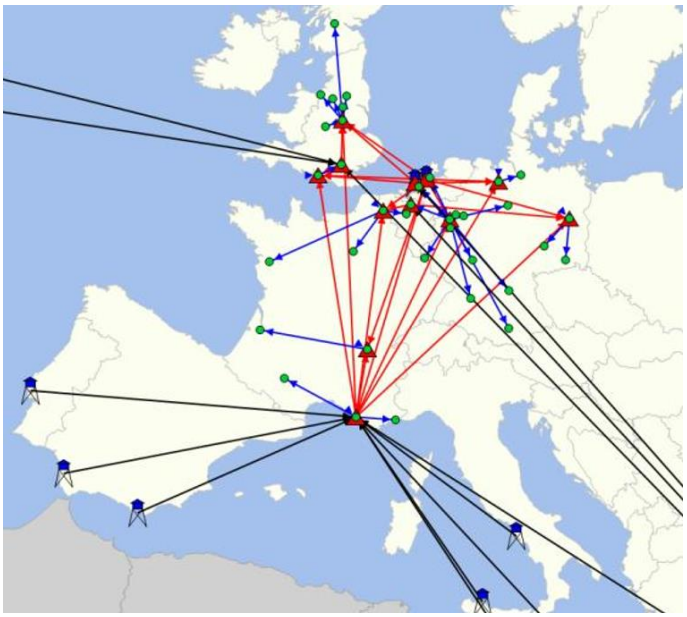
Appendix figure 3, Infra-EU trade map as part of the world floriculture map 2016 (Rijswick, 2016)



Appendix figure 4, Cut flower imports EU market as part of the world floriculture map 2016 (Rijswick, 2016)



Appendix figure 5, Flowchart future logistics design

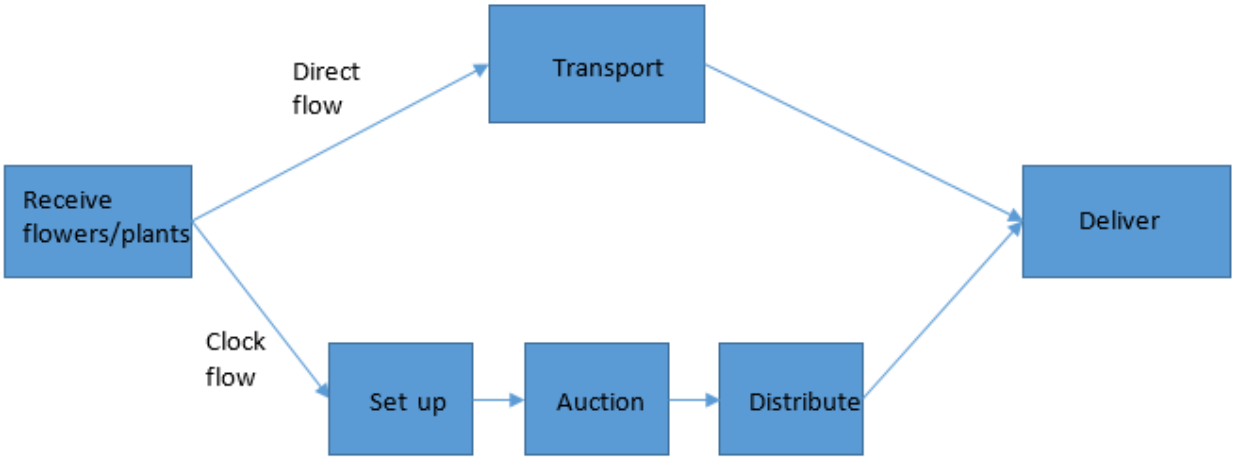


Appendix figure 6, Result hub-study (Verhoeven, 2014)

A3 Actions of Royal FloraHolland to achieve 2020 vision requirements

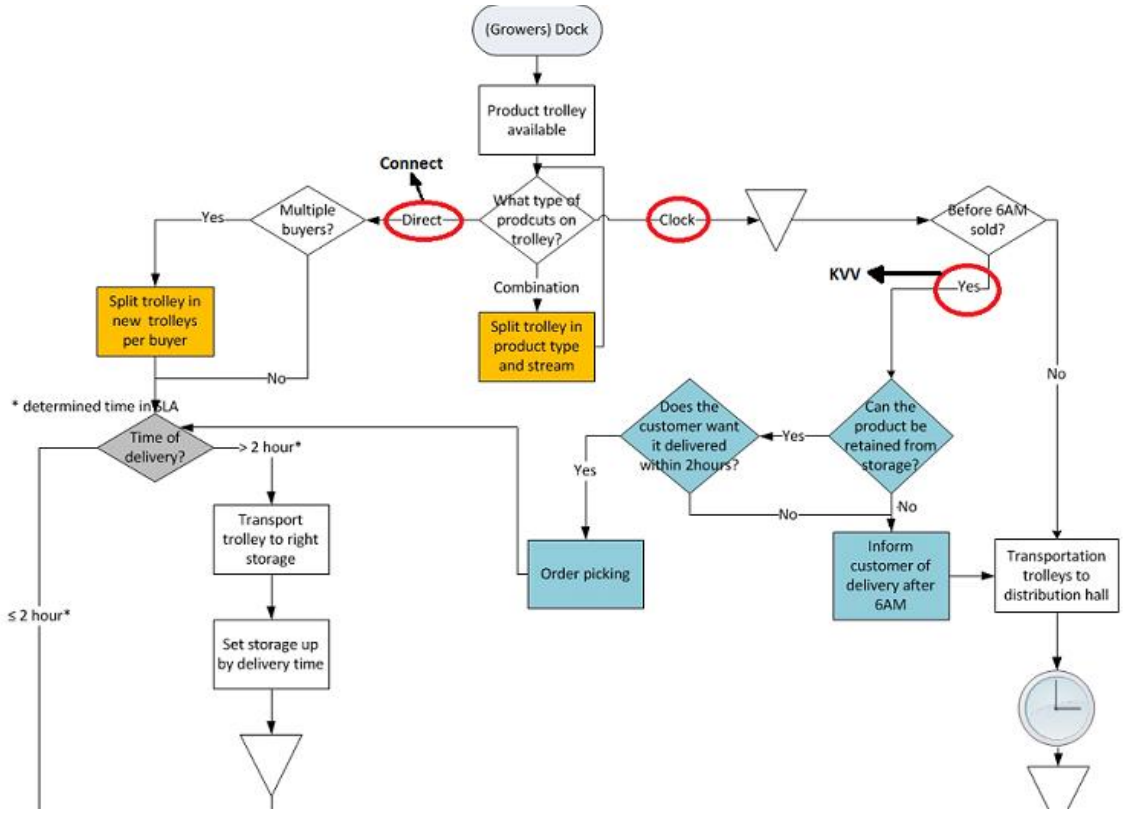
The actions of the auction house Royal FloraHolland to achieve the 2020 goals are described in this section. Looking what happens inside the company, the incoming products have a few differences that will influence the logistic process. The first difference is that they will either come in with an address or without an address, so sold or unsold. When the address is not determined, this will be done after the moment of sale.

At this moment the incoming connect/cross-dock flow already has a final address. And the flow without an address will be sold using clock sales. Other sales propositions are being discovered to optimize logistics.



Appendix figure 7, Logistical outline of Royal FloraHolland, distinction between direct and indirect flows

As shown in Appendix figure 7 the incoming stream of products can be divided in direct flow and clock flow, the indirect flow. Within Royal FloraHolland many commercial transaction flows are in operation or developed for the coming years. The direct, clock and KVV flows (explained on the next page) are already in operation in 2016. Their connection is shown in Appendix figure 8.



Appendix figure 8, Concept flowchart, adjusted from Stubbé (2016)

In the near future, six incoming commercial transaction flows can be recognized in the plans of Royal FloraHolland. Those flows are a combination between the currently active flows, and flows that will probably become operational in the coming years until 2025 according to logistics managers within Royal FloraHolland. The 6 commercial transaction flows that can be recognized are:

<u>Currently active flows:</u>

- Connect – Direct sale from grower to customer. Logistics can be done by Royal FloraHolland or other company (Buiten veiling om, BVO);

- Clock sale – The ordinary auction sale explained in paragraph 2.1 when someone can buy on one clock at the same time. Those clocks are virtual at this moment, there is a platform that supports buying from distance (Kopen op Afstand, KOA) as well, making it possible to buy on more clocks at different locations at the same time;

- Klokvoorverkoop (KVV) – Grower can offer maximum 30% of its' products via KVV. Those products may be sold before the clock sale starts at a price set by the grower. Distribution starts after the last clock sale on the trolley;

<u>Future flows:</u>

- Vandaag voor Morgen (VvM) – Selling products via the digital clock principle (digital greenhouse) when they are still at growers' location (Aftuin) on the day before distribution. Logistics are handled via Royal FloraHolland. Products that are not sold can be sold via the normal clock sale the next day;

- Landelijke klok or Vandaag voor Vandaag (VvV) – Current clock sales are separated per location, in VvV a nationwide platform will perform the clock transactions for all locations at the same time;

- Leveren uit voorraad (LuV) or InStore – Growers can offer their goods for direct sale with a possibility to of storing their goods at a FloraHolland location. Price setting is direct in this case and not via the clock.

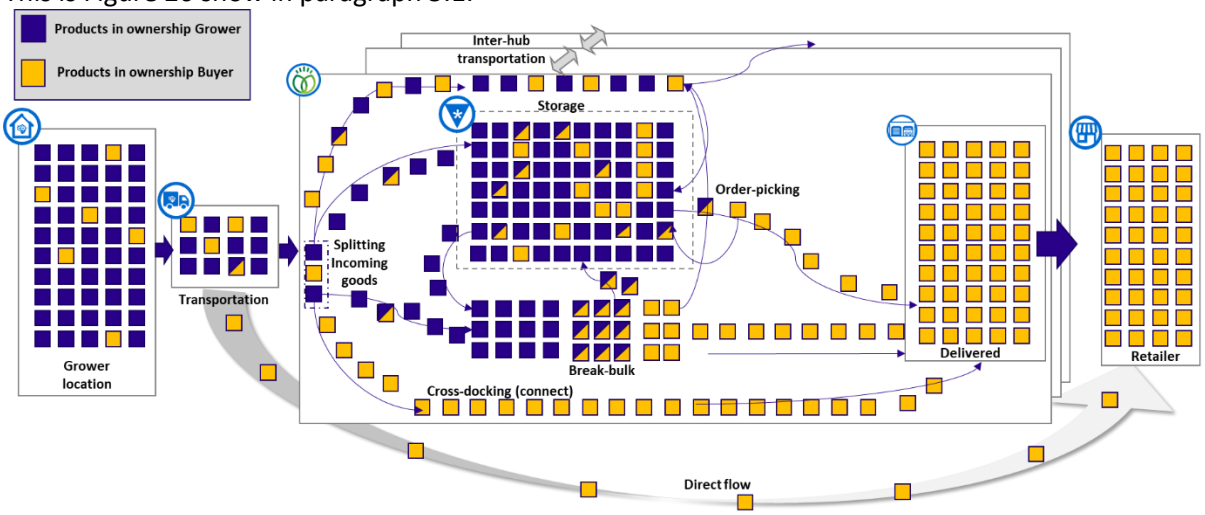
In the table below an overview of the 6 commercial transaction flows and their specifications is given. This information has been clarified during conversations with Royal FloraHolland employees.

	Price setting	Entering addressed	Second sale possibility	Aftuin possibility
Connect	direct	yes	yes	yes
VvM	clock	yes	yes	yes
Clock	clock	no	no	no
KVV	direct	no	yes	no
VvV	clock	no	no	no
LuV	direct	no	yes	no

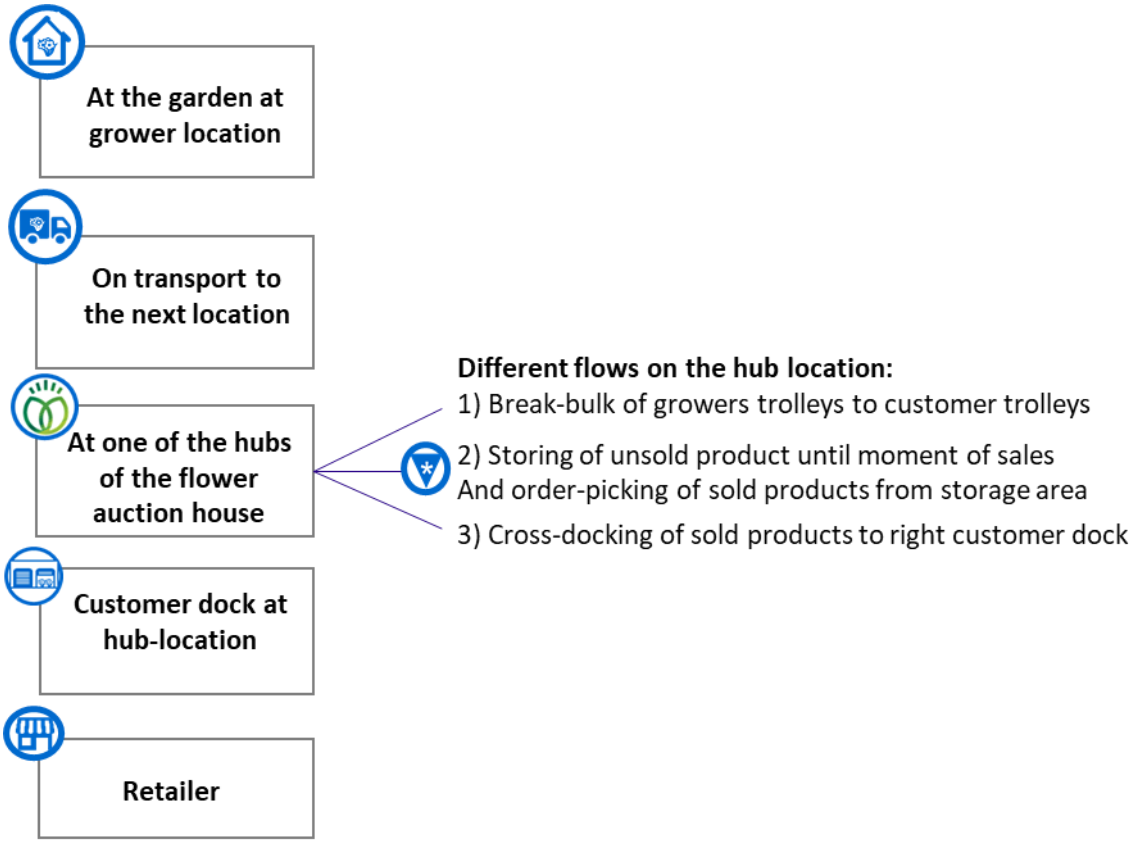
In this section the general picture of the floricultural supply chain and the trends and developments in this supply chain has been sketched.

A4 Explanation parts conceptual design virtual storage

The next picture is the complete overview of products in the first part of the floriculture supply chain. This is Figure 26 show in paragraph 5.1.



The figure consists of various physical locations in the floriculture supply chain:



Appendix figure 9, Explanation parts of virtual storage figure