SERIOUS GAME SCENARIOS FOR VIRTUALISED CHAINS

EXPLORING FUTURE SCENARIOS FOR VIRTUALISED QUALITY DRIVEN LOGISTICS IN THE DUTCH FLORICULTURAL SECTOR

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1. Introduction

The Dutch floricultural sector currently has a leading position in Europe, organised in value chains and clusters where auctions and a large number of independent growers, traders and logistics service providers work together to supply (inter)national markets (De Keizer et al, 2014; Porter et al, 2011).
Logistic chains in the floricultural sector are composed by multiple stakeholders, at different points in the chain: growers, logistics service providers, wholesales, florists, supermarkets and consumers. They have a wide knowledge about growth and care of floricultural products and a vast assortment of products to offer.

Recent events can harm the strong position of the Netherlands in the near future. A first event is the emergence of markets worldwide located at a greater distance from the Netherlands. This makes it more difficult to reach them efficiently and effectively. Secondly, consumers have higher requirements, such as longer and guaranteed shelf life and transparency of production processes. Thirdly, traders are ordering with a higher frequency, in smaller quantities and with shorter lead times directly from growers, which leads to more transport movements. The final event is the shift of production volumes to other countries: new competitors like Italy, Spain and Poland are entering the arena. These countries are gaining market share very rapidly, by providing a wide range of supplied products of high quality and low production costs (De Keizer et al, 2014).

Without innovative action, the Netherlands might lose its renowned international position. It is therefore crucial to keep the leading position of the Netherlands, by guaranteeing high flower quality in the market. Improved quality can be achieved via more efficient chain and a well-functioning quality control. To this aim, transparency about quality information through the logistic chain plays a major role.

DaVinc3i community project started in May 2016 as the continuation of *DaVinc3i* project (2010-2015) and it aims at collecting and disseminating knowledge about quality-driven logistics in the Dutch horticultural sector. The concept ‘quality controlled logistics’ stresses the importance of engineering and monitoring logistic processes to deliver high quality products to end consumers. Quality controlled logistics hypothesizes that if product quality in each step of the supply chain can be predicted, logistic processes can be (re)designed resulting in better product quality and fewer product losses.

In particular, in the *DaVinc3i community* project explores the role of virtualisation in establishing quality-driven logistics. Virtualisation can be defined

as the digital representation of historical, present and future states of a physical object (Verdouw et al. 2015).

Through virtualisation logistic processes are simulated using software systems instead of conducting physical experiments (Van der Vorst et al. 2011). Additionally, virtualisation allows more transparency of quality information and hence the adjustment of logistic processes to maintain flower quality.

Virtualisation is possible through sensor technologies that are used to record the location and quality information over the whole chain. Technologies like RFID, Time Temperature Indicators (TTIs), controlled atmosphere storage rooms and refrigerated containers can track and control flower quality decay throughout the logistics network.

At the end of the *DaVinc3i* project in 2015 it emerged that despite the availability of such technologies, there is still insufficient insight into how they can be used for virtualised quality-driven chains. To stimulate the adoption of virtualised quality controlled logistics, actors in the chain need to better understand the role of such technologies in monitoring and adjusting supply chain management. Additionally, it is important that all actors coordinate within the chain and share quality-related data.

This appears to be a challenging task because of several barriers, such as the lack of trust among the different stakeholders in the chain, the unclarity about their roles and responsibilities, and their little attention to consumer requirements. A more detailed description of such barriers can be found in deliverable D 3.1 wrote by Kelly Rijswijk. Kelly Rijswijk is responsible for Working Package 3 of the *DaVinc3i community* project, dealing with social innovation for quality controlled logistics.

To overcome these barriers a mind shift is needed from businesses actors in the chain to implement virtualised quality driven logistics. In the framework of the *DaVinc3i community* project, this mind shift will be stimulated through a serious game that allows participants to simulate their business processes in different scenarios.

The aim of this deliverable is to present how a serious game can be applied to stimulate a mind shift in implementing virtualised quality-driven logistics in the floricultural sector. The reminder is structured as follows. Firstly a brief introduction about the benefits of virtualisation is given. Secondly the challenges for the sector and its stakeholders are described. Thirdly the game is presented. In particular, three game scenarios are introduced, based upon a literature review and interviews with relevant stakeholders from the sector. The three scenarios are: i) the current situation scenario; to show the impact of current logistic processes on flower quality decay, ii) the perfectly virtualised chain; to

show the benefits of virtualisation in quality-controlled logistics, iii) the steps needed for virtualising; to explore the challenges to virtualising and to stimulate discussions about how to overcome them.

2. The benefits of virtualised quality driven logistics

Quality decay of floricultural products is mainly determined by the duration of logistics operations (like transport, storage or processing) in combination with the (variation of) temperature under which the operations are executed (Van der Vorst et al., 2009; Rong et al., 2011). Long durations prolong quality decay and high temperatures further accelerate this decay.

In a virtualised chain planning, monitoring, adjustment and optimization of logistic processes are decoupled from the physical logistics flow and can be carried out remotely via the Internet (Ho et al. 2003, Verdouw et al. 2013).
From June till December 2016 we conducted a literature review of reports and scientific papers about virtualised quality driven logistics in the horticultural sector. The literature review revealed several benefits of virtualisation (figure 1).

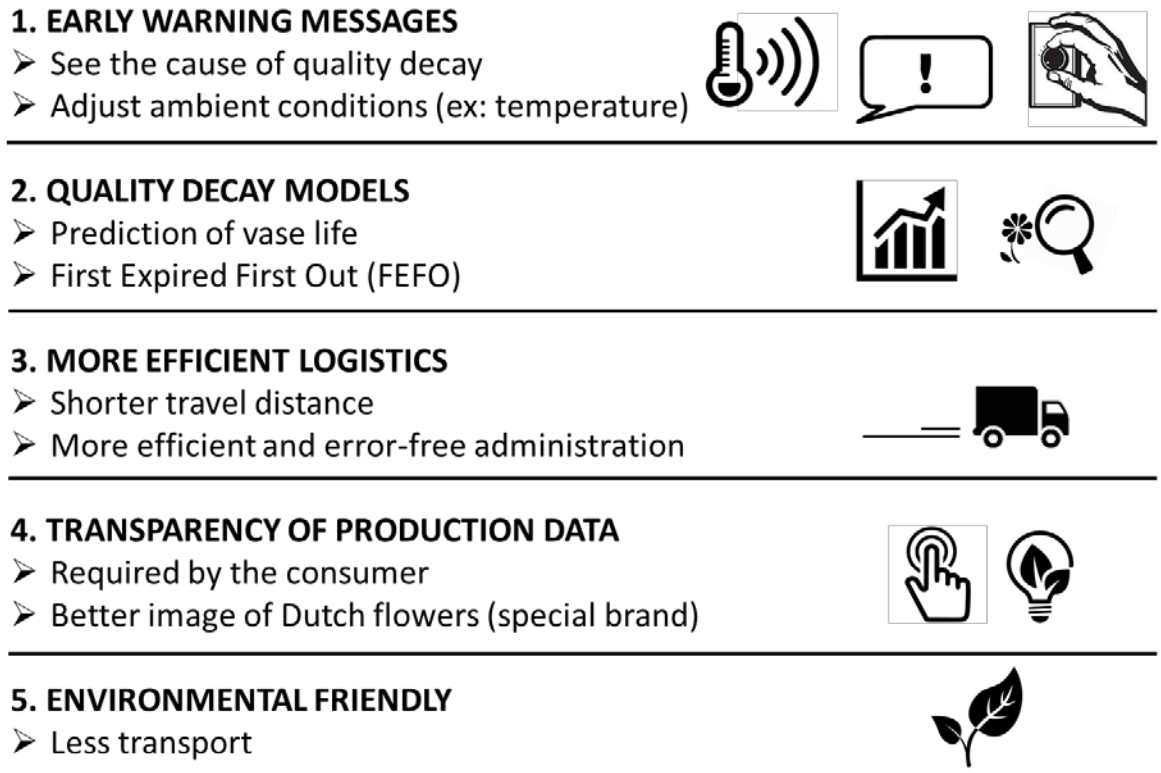

Figure 1: Benefits of virtualised quality driven logistics

An important benefit of virtualisation is the availability of real-time product information. This allows optimising logistic processes, for example through early warning messages in case of changes in ambient conditions that might result in quality decay. Another benefit is that virtual objects make it possible to

reproduce the historical state and to simulate the future state of the product. The simulation of future state is possible thanks to quality decay models, which predict the flower vase life. Estimation of shelf life and information on product quality decay can be used to optimise stock rotation systems like 'first expired first out' (Jedermann et al., 2014), or to reduce waste by providing an estimate of remaining shelf life (Grünow & Piramuthu, 2013). Hence through virtualised quality-driven logistics, processes are monitored continuously in the chain, adjusted and optimized based on real-time information about product quality (Van der Vorst et al., 2011).

Moreover virtualisation allows skipping chain stages through which products used to physically pass through, such as logistics hubs, especially around the auction sites (Verdouw et al. 2013, de Keizer et al. 2015). This implies that the travel distance is shorter and hence the logistics are more efficient and environmentally friendly. Finally, virtualisation allows for transparency of production data, which is increasingly required by consumers.

3. Challenges for the sector and its stakeholders

In December 2016 we conducted interviews with stakeholders from the Dutch floricultural sector to understand the current challenges for the sector and its stakeholders. Interviews were held with producers, wholesaler and organisations such as the Dutch Association of Wholesalers in Floriculture Products (Vereniging voor Groothandelaren in Bloemkwekerijprodukten, VGB), the Flower Transport association (Sierteeltvervoer, VSV), Royal Flora Holland, Floricode and Wageningen University.

As a result of the interviews, we conclude that a first challenge the sector is facing is the lack of a sense of urgency to keep flower quality high. It appears that stakeholders are focused on their own business processes and focus on quality decay only at the moment of purchase. They are not aware of the logistic processes outside their control and, most importantly, on their impact on quality decay. This might be due to the fact that there is little or no specification from producers about how different flower species should be handled and no clear agreement about stakeholders' responsibility to keep flower quality high.

A second challenge is the lack of coordination among stakeholders in monitoring and controlling flower quality. Currently quality monitoring is implemented in scattered points in the chain, mainly before each purchase. This signifies that quality check is not performed continuously in the chain and information about quality is not shared. Additionally, the monitoring of product quality is done mainly with data loggers, which can be read and interpreted afterwards. Hence the current system does not allow making real-time decisions to adjust logistic processes to keep flower quality high.

A third challenge is that there is little knowledge about virtualised quality-driven logistics and what are its benefits. It appears that stakeholders are not yet aware of the role that virtualisation might play in quality control.

These results show that several changes are needed for the sector to virtualise. The first one is creating awareness about future possible scenarios, such as the emergence of competitors from abroad and more demanding consumers that require a longer shelf life and more transparency about production processes. This awareness would trigger stakeholders` interest in coordinating to keep flower quality high.

The second one is making stakeholders aware that quality decay is caused by a series of events in the whole chain and that everyone should be responsible to keep quality high, in order to ensure future viability of the sector. This awareness is likely to trigger more coordination among stakeholders in the chain to keep quality high.

The third one is to introduce the benefits of virtualised quality driven chain and the necessary steps to accomplish it. Such a process appears to be challenging. For instance sharing data about product quality is beneficial for the rest of the stakeholders in the chain but a stakeholder might fear that it could put their commercial interests at risk. A more detailed overview of such barriers can be found in deliverable D3.1.

4. Simulation gaming as a method for awareness raising

Simulation gaming is a participatory approach increasingly used by business actors and social scientists, with multiple objectives. One objective is to exchange knowledge among game participants. In fact participants often have different knowledge and perception of their environment that can be shared to tackle a certain common problem. A second use is as a tool to improve communication and coordination. The informal setting of games provides a relaxed atmosphere, reducing the social distance between players and improving dialogue between them. A third use is as an experimental environment: the game can be used as a platform to simulate and discuss about different future scenarios, stimulating engagement and promoting joint decision-making (Hofstede et al, 2010).
Hence simulation gaming can be a powerful tool for improving communication and triggering discussions about a strategic plan for a common benefit. Such characteristics make it particularly suitable for promoting communication and social innovation necessary in order to achieve virtualised quality-driven logistics.

5. Game design

We designed a simulation game in a form of a board game to be played by stakeholders of a floricultural chain: (two or more) producers, (two or more) wholesalers, (two or more) logistics providers, one auction, (two or more) shops and (two or more) consumers. Optionally, other player roles can be introduced, such as a competing producer who determines price according to the vase life and guarantees high quality or a costumer that is willing to pay more for guaranteed vase life. Ideally the game should be played by stakeholders from the same chain. This is because discussions and decisions during the game-play can reflect reality; hence it's hoped that the game triggers stakeholders to explore possible collaborations in reality as they have done in the game. The game has multiple goals, which are tackled in three game scenarios.

The game represents the logistics in the floricultural sector and players can play the same role that they have in reality or another stakeholder`s role. Each stakeholder has resources in the game that mimic real resources: money, flowers and knowledge about flower quality. In the following sessions three game scenarios are described, with their associated goals. The main goal of players is running their own business and making sure that the quality of the flowers remains high throughout the chain up to and including the consumer. A first game prototype has been played in a workshop organized in the context of the DaVinc3i community project to gather feedback about its content and playability.

Scenario 1: Quality decay in the current situation
This scenario depicts the current logistic processes and their impact on flower quality decay. The chain consists of several stages, represented on the game board (figure 2). Two chains are represented: one that passes through the auction (longer chain) and one that goes more directly to the wholesale (shorter chain).

Figure 2: Representation of the two logistic chains in the game board: i) through the auction and ii) to the wholesaler directly.

We represented the impact of logistic processes on quality decay by means of event cards. Each player at his/her turn has to pick an event card that describes

a certain event, which has an impact on flower quality. He/she needs to choose to respond to each event in a certain way, which has an impact on the shelf life. Shelf life is represented in the game by tokens stored in a black box, each of which represents one day. A certain number of tokens is removed by the game facilitator from the box according to the player's decision. The fact that the box is black implies that players cannot see its content and hence the impact of their decisions on the shelf life. This reflects reality: in fact stakeholders in the chain do not have an overview of what happens to the flowers at each logistic step. Additionally, even when quality check is performed, flowers may appear to be of good quality but have short shelf life.
After deciding how to act in the situation described in the event card, players can choose to share their decision with the rest of the players or to keep it secret. This also reflects reality: stakeholders might decide not to share information with the rest of the chain about flower quality and what they did (or omitted) to keep flower quality.

The main goal of this game setting is to show that the decay of flower quality is the result of decisions taken throughout the chain and hence that everyone is responsible for keeping the quality high. At the end of the game round, the consumer will rate the quality of the flower based upon the shelf life and decide to stop buying a certain flower or from a particular shop if the quality is too low. In fact, in the game as well as in reality, consumers' decisions have an influence on the business of all the players.

Scenario 2: the perfectly virtualised chain
This game scenario represents the logistics processes in a perfectly virtualised chain. A first characteristic of this scenario distinguishing it from scenario 1 is a more direct route from producer to end customer (no need to pass through the auction; figure 3). In fact, the emergence of online shops and auction results in trade becoming virtual and products no longer having to be physically present at the point of sale. This implies that there are fewer events (cards) than scenario 1 that might have an impact on flower quality.

Information on product quality decay is represented in the game by informing players about the result of quality decay models: the impact on shelf life of each decision made after the event card. Based upon this information players have the opportunity to optimize the logistics in the chain, by for instance selling flowers with estimated low shelf life before (First Expired First Out) or by adjusting the price of the flower.

Additionally, the remaining shelf life can be seen by the whole chain because the tokens representing it are not in a black box (as in scenario 1) but in a transparent box. This game design is introduced to see what the impact of this transparency of information is on players' decisions.

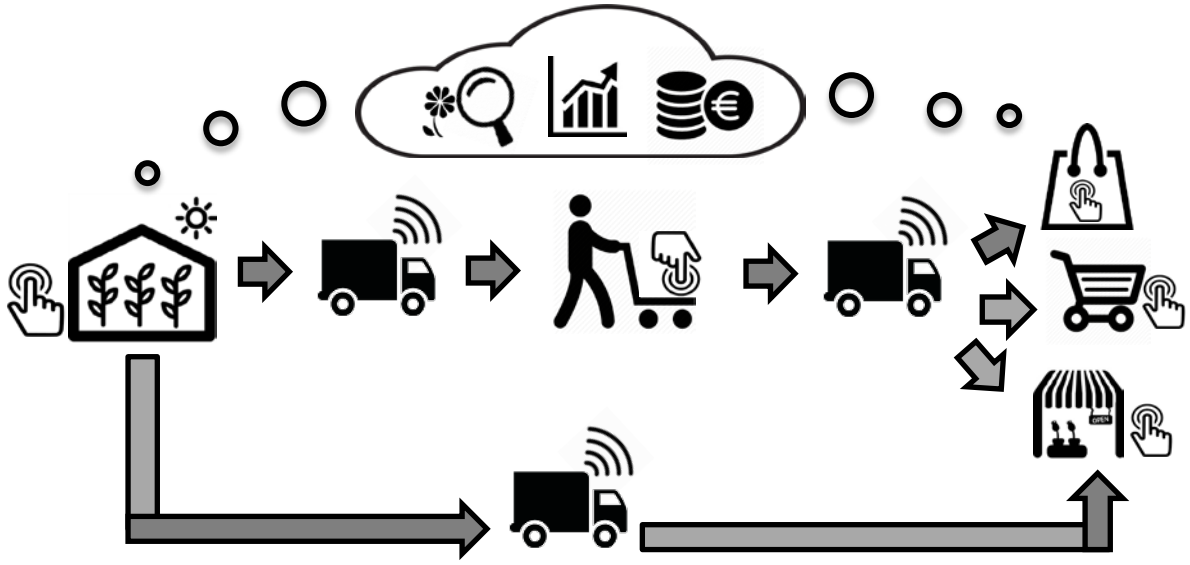

Figure 3: Game board representing the logistic chain in a perfectly virtualised scenario

Scenario 3: Steps towards virtualising

This scenario introduces the steps to virtualise (figure 4).

Flowers should be identified by barcodes or RFID tags and have a temperature sensor that travels with them through the whole chain. This allows to track and trace their location and to monitor their ambient temperature. To this aim, it is mandatory that all the stakeholders in the chain use such sensors, to collect temperature data in each logistic step. Additionally, all the stakeholders in the chain have to share data in the chain though an online platform.

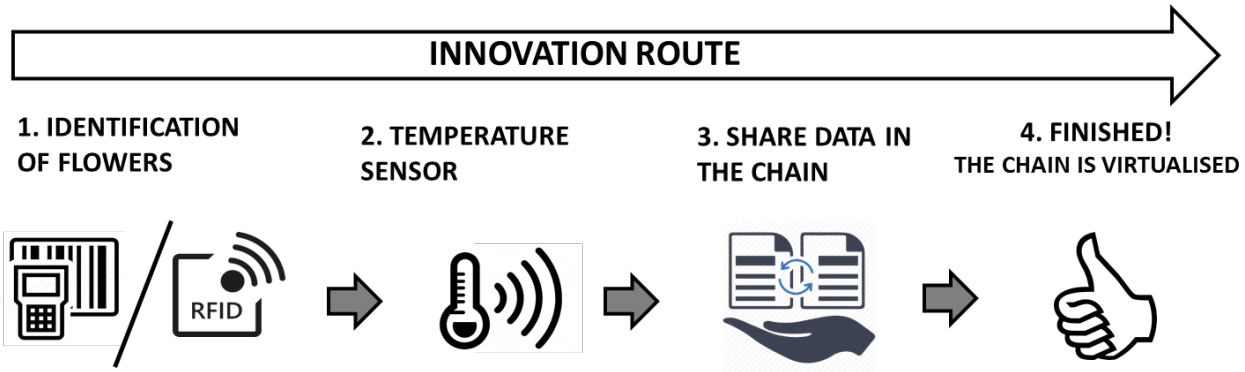

Figure 4: Innovation route displaying the necessary steps to virtualise.

The goal of this scenario is to trigger discussions about challenges that are likely to arise in the virtualisation process and to show that virtualised quality-driven logistics is possible only if the stakeholders in the chain coordinate in flower quality monitoring. In fact flower quality needs to be monitored continuously

throughout the chain and data should be shared real-time to allow optimisation of the logistic processes. Data sharing can be a delicate process because it might put the commercial interests of stakeholders at risk. For instance, concerns might arise from free riders that use the data shared online; hence discussions might arise from who has access to which data.

6. Conclusions

The present deliverable describes the work conducted in the context of WP2 of the DaVinc3i community project. The project aims at collecting and disseminating knowledge about the role of virtualisation in establishing quality-driven logistics. Despite the availability of technologies for virtualisation, several barriers hamper its implementation. This deliverable describes how a simulation game can be used to overcome these barriers and to support a mind shift from stakeholders of the sector in adopting virtualised quality driven logistics.

A first barrier is the lack of a sense of urgency from the sector to keep flower quality high. It appears that stakeholders are not fully aware of the logistic processes outside their control and, most importantly, their impact on quality decay. A second barrier is the lack of coordination among stakeholders in monitoring and controlling flower quality. Currently quality monitoring is implemented in scattered points in the chain, mainly before each purchase. A third barrier is that there is little knowledge about virtualised quality-driven logistics and its benefits. It appears that stakeholders are not yet aware of the role that virtualisation might play in quality control.

The aim of the game is to address these barriers through three scenarios. The first game scenario represents the current situation and it shows the impact of current logistic processes on flower quality decay. The second scenario introduces how logistics would be in a perfectly virtualised chain to show the benefits of virtualisation in quality-controlled logistics. The third scenario presents the steps needed for virtualising, to explore the challenges to virtualising and to stimulate discussions about how to overcome them.

The game presented in this deliverable is a prototype which has been tested and improved through two workshop sessions in January 2017: one with colleagues at the Operations Research and Logistics group at Wageningen University and one with stakeholders from the sector at the Agricultural Economics Institute (LEI) in Den Haag. The game will be improved in the coming months as a result of further interviews with technical experts and stakeholders from the sector. Additionally other game sessions will be organised with students and the general public to improve its playability.

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