THE VIRTUALISED CHAIN GAME

OVERVIEW, DESIGN CONCEPTS AND DETAILS

DELIVERABLE NUMBER D2.2

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Contents

1 Introduction

This deliverable describes the first prototype of the "Virtualised chain game", developed by Giulia Salvini in the context of the DaVinc3i project in the period of January till July 2017.

The game is aimed at introducing its participants to the benefits of virtualisation for quality driven logistics in the Dutch floricultural sector. Virtualisation can be defined as the digital representation of historical, present and future states of a physical object (Verdouw et al. 2013). A major benefit of virtualisation is that it allows to monitor the location of flowers and the impact of ambient conditions on flower quality during logistics. The ambient conditions that have a major impact on flower quality decay are temperature, humidity and ethylene. In this game we focus on temperature as the main ambient factor, as technologies to monitor humidity and ethylene are not yet fully operational. A fully implemented virtualised chain implies that location and temperature data are continuously shared in the cloud, while quality decay models calculate the expected remaining shelf life. Sharing this information real time allows to adjust logistic processes to maintain flower quality or to deliver flowers to the right customers. In fact different customers are willing to pay a different amount based upon flower quality.

Technologies that allow virtualisation are advancing, including RFID tags, Time Temperature Indicators (TTIs), controlled atmosphere storage rooms and refrigerated containers that can track and control flower quality decay throughout the logistics network. Despite the availability of such technologies, there is still insufficient insight into how they can be actually used for virtualised quality-driven logistics.

To stimulate the adoption of such technologies, actors in the chain need to better understand their benefits 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 confusion about their roles and responsibilities, and their little attention to customer requirements (deliverable D1.1). Given these barriers, the aim of the "Virtualised chain game" is to facilitate learning and communication on virtualised quality driven logistics among different stakeholders in the floricultural chain in the Netherlands.

The current game version is the result of interviews conducted from February till June 2017 with experts in: game design, flower logistics and quality decay.

The structure of the deliverable follows the *Overview, Design concepts and Details* (ODD) protocol, as introduced by Volker Grimm et al. (2006). Such protocol is used to describe games and models and it is composed of three sections: Overview, Design concepts and Details. The *Overview* section introduces the game goal and its elements; the *Design concepts* section describes the basic principles of the game and the expected outcomes; the *Details* section describes the parameterisation of the game.

2 Overview

2.1 Game Purpose

The game is in a form of a board game, designed to be played by stakeholders of a floricultural chain: (two or more) producers, (two or more) wholesalers, (two or more) logistics providers, one auction and (two or more) shops (figure 1). The minimum amount of players is four (one producer, one transporter, one wholesaler and a shop manager of all shops. A key factor in the game is flower quality decay. In fact, in the moment in which flowers are harvested by the producer their shelf life starts decaying, along with their value. The speed of this decay depends upon a combination or time and temperature and it can be prevented through a series of investments from the different actors in the chain.

The game has three main purposes. The first purpose is to make players more aware of events which have an impact on quality decay and hence to encourage a more holistic view of the logistic processes. The second purpose is to show the benefits of virtualisation in monitoring quality decay and its use to maximise logistic processes. The third purpose is to introduce what are the necessary steps to virtualise and trigger discussions about possible challenges as well as possible solutions. These three aims are tackled in three game scenarios: i) the current situation scenario, ii) the virtualised chain scenario and iii) the steps to virtualise (section 2.3).

2.2 Entities, state variables and scales

In the game we distinguish eleven types of entities: seven agents, which represent the main stakeholders in the sector (the producer, the transporter, the wholesaler and three flower shops). An auction, the bank, the flowers and a black box that represents flower quality decay. The consumer role is not played, but it's implicit in the game. Participants play the role of one of the seven agents, who need to run their business activities by buying and selling flowers, making investments and by carrying out activities to minimise quality decay.

In the game the impact of logistic processes on flower quality is represented by means of event cards that describe a certain event. Players can choose to respond to the event in a certain way, each with a different impact on the shelf life. Shelf life is represented in the game by tokens stored in a black box, each of which represents one shelf life day. A certain number of tokens is removed by the game facilitator from the box according to the player's decision. The black box implies that players cannot see its content and hence are not aware of 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. Also in reality even when quality check is performed, flowers may appear to be of good quality but in fact 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 to keep flower quality. The main goal of this game setting is to show that quality decay results from decisions made throughout the chain and hence that everyone is responsible for it.

In the virtualised scenario, where technologies are used to monitor and prevent quality decay, event cards notify the player about the impact of each decision on the shelf life and hence they can make more informed decisions. Additionally, players are informed about the remaining shelf life and hence they can decide to sell flowers to the shop with the corresponding required shelf life (figure 1).

The following sections introduce the eleven entities and describe the business decisions and the investments that the agents can make.

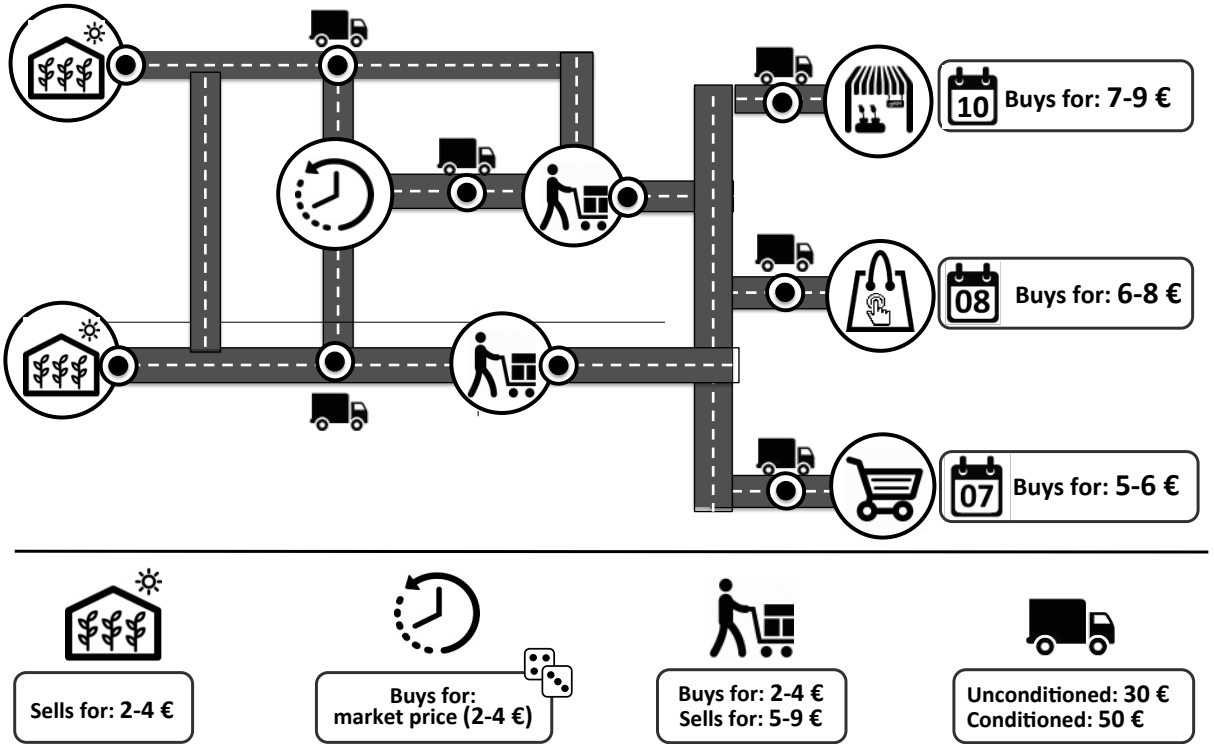

Figure 1: Game board representing i) the different logistic routes: from the producer to the wholesaler (directly or through the auction), to three different shops (small flower shop, online shop and supermarket); ii) the shelf life required by each shop and the offered price and iii) the selling and buying price of the different actors. At every small circle the player has to pick up an event card.

2.2.1 The producer

The producer cultivates and grows flowers, which have three different growth phases: seedling, young and mature (figure 2). After each game round flowers are shifted to the next growth phase. Once the flowers are at the mature stage the producer can sell the flowers to the wholesaler, either directly or via the auction (figure 1). In the first case the flower price is determined by the wholesaler and can be negotiated, while in the second case the price is determined by the market, which is simulated by throwing dices, with values from 2 to 4 euro.

The producer can buy seedlings from the bank and can do a series of actions to grow flowers: spray them with anti-fungi, provide them with water and fertiliser and protect them with anti-frost, anti-wind and anti-heat covers (figure 4). Finally they can choose to store them (once they are at the mature stage) in three types of cooling chambers, characterised by a different temperature and associated price (figure 4). Additionally the producer has to pick up a card describing an event that might have an impact on flower quality and he/she needs to decide how to act accordingly. When decided what to do, he/she can share the event with the rest of the players or not.

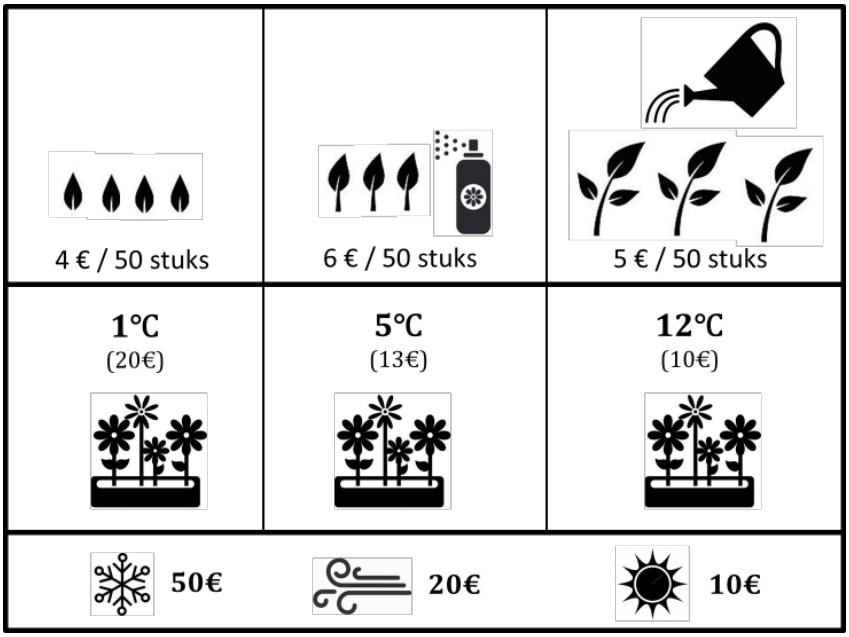

Figure 2: The business board of the producer. The producer can make investments including: buying seedlings, applying snit-fungi spray and fertilizers (top part). Additionally he/she can decide to store flowers in three different cooling chambers: at 1°C, 5°C or 12°C, each with associated price (middle part). Finally the producer can invest in covers against frost, wind and heat (lower part).

2.2.2 The auction

The auction is an external entity and hence it`s not meant to be played. It represents a market platform between producers and wholesalers. Producers that decide to sell flowers though the auction deposit them there and wait that wholesalers will buy them. The price of flowers is determined by the market, which in the game is given by throwing a dice. In case not all the flowers are bought by a wholesaler the bank will buy them.

2.2.3 The wholesaler

The wholesaler can buy flowers from one or more producer directly or through the auction and can sell them to the three different type of shops (figure 1). The challenge of the wholesaler is to keep flowers in stock as short as possible to maximise their profit. In fact the wholesaler has to pay for flower storage. The wholesaler can store flowers in different cooling chambers, characterised by a different temperature and associated price (figure 3). Flowers will lose shelf days according to the time they stay in deposit. Before selling the flowers the wholesaler has to pick up an event card that describes an event with a certain impact on the shelf life decide how to act accordingly. He/she can share the decision with the rest of the players or not. When getting flowers ready for transport the wholesaler can decide to protect flowers or not from different types of weather conditions: heat, wind and frost, each with a certain cost (figure 3).

2.2.4 The transporter

The transporter has the function to transport flowers from the producer to the other actors in the chain (wholesaler, auction and shops). He/she can offer a cooled or not cooled transport, with different prices (figure 1). At each turn he/she needs to pick up an event card describing an event that might have an impact on flower quality and decide how to act accordingly. When decided what to do he/she can share the event with the rest of the players or not.

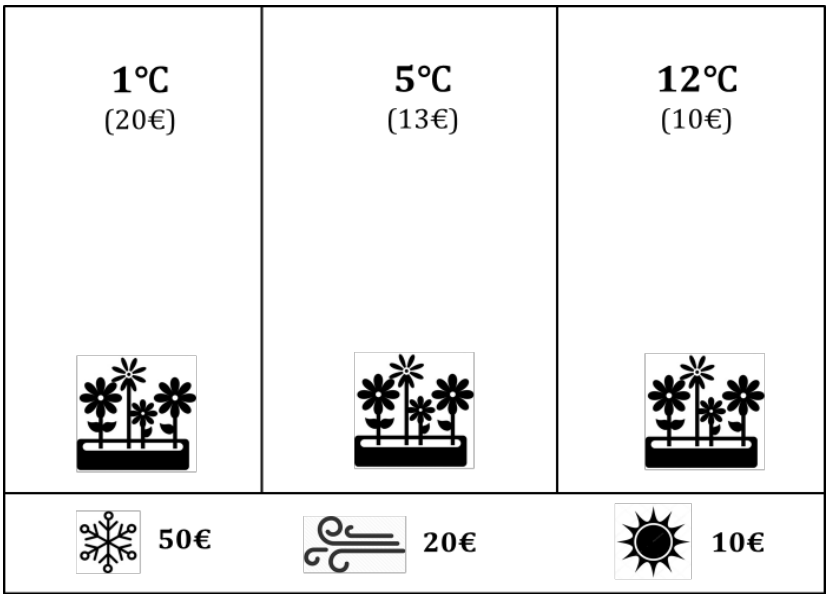

Figure 3: The business board of the wholesaler. The wholesaler can store flowers in three different cooling chambers: at 1°C, 5°C or 12°C, each with associated price (top part). Additionally the producer can invest in covers against frost, wind and heat (lower part).

2.2.5 The three flower shops

The game has three flower shops: a small flower shop, a supermarket and an online shop. These shops differ according to the required shelf life, the offered price and their stock (figure 1). After buying flowers shops will evaluate if the flower shelf life corresponds to the price that they paid. If the shelf life is lower than what they paid for they may make decisions that can harm the profitability of the actors in the chain. For instance they could decide to stop purchasing flowers from the wholesaler who delivered poor quality flowers or ask him/her to pay a fine.

2.2.6 The bank

The facilitator plays the role of the bank, which sells seedlings to the producer and investments to all the actors. Investments include: cooling chambers and flower protecting covers.

2.2.7 The flowers

Flowers are sold and purchased throughout the game by the different players at different prices (figure 1). Flower quality decay is represented by the black box.

2.2.8 The black box

Flower quality decay is represented by tokens stored in a black box. The facilitator removes the amount of tokens in the box according to the decisions made by each player. The black box implies that players cannot see its content and hence are not aware of the impact of their decisions on the shelf life. Hence only the facilitator can see the context of the black box.

2.3 Process Overview and Scheduling

The game consists of three scenarios: i) the current situation scenario, ii) the virtualised chain scenario and iii) the steps to virtualise. Each scenario can be played for 2-4 rounds and can last 30 to 60 minutes. Each round consists of the logistics from the producer to the one of the shops and it consists of three phases. In the first phase (which lasts months in reality) flowers grow at the producer and investments can be made by each actor; in the second phase (which lasts days in reality) flowers are sold and transported through the logistic chain; in the third phase (which lasts days in reality) flowers reach the shops and their shelf life is revealed.

In scenario one the current situation is played: players do not know the impact of their as well as other players` decisions on flower shelf life. In scenario two a virtualised chain scenario is played: when picking up the event card players are informed about the impact on shelf life of each decision. Additionally, all the actors in the chain can see the remaining shelf life because the tokens representing it are not in a black box (as in scenario one) but in a transparent box. This game design is introduced to evaluate the impact of transparent information on players' decisions.
Based upon this information players have the opportunity to optimize the logistics in the chain, by for instance selling flowers to the shop with a particular shelf life.
In scenario three the steps to virtualise are introduced (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.

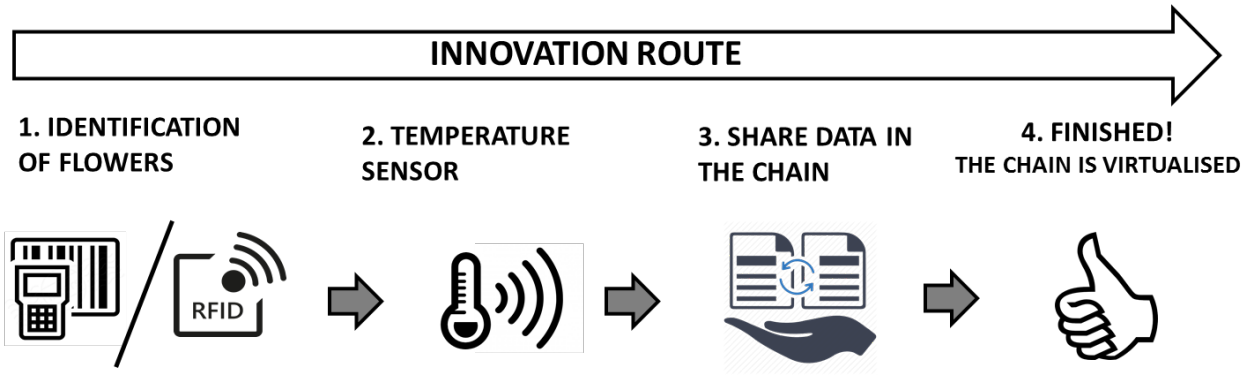

Figure 4: Innovation route displaying Scenario 3: Steps to virtualise.

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.

3 Design Concepts

3.1 Basic principles

A key aspect of the game is quality decay, which is determined by the decisions and investments done by the different actors (players) in the chain. At the end of each game round if few actions throughout the chain have been taken to lower quality decay, flowers will arrive at the shops with low shelf life. Shops can then make decisions that can have an impact on the profitability of actors in the chain. For instance they could decide to stop purchasing flowers from the wholesaler who delivered poor quality flowers or ask him/her to pay a fine. Consequently the wholesaler will do the same with the producer, who will maybe blame the transporter. Hence all the actors will lose from the low quality flowers they delivered in the previous round, paradoxically also the actors who did make investments to keep flower quality high. But who`s fault is it? This question arises in a system in which there is lack of transparency, the quality decay in the black box! In the second scenario, where virtualisation is introduced, players have the opportunity to see the causes of quality decay: shelf life is contained in a transparent box instead of a black box. Hence players can either prevent quality decay or channel flowers to shops according to their estimated remaining shelf life. Once the benefits of a virtualised chain are visible, the necessary steps to virtualise are introduced and discussion among players is encouraged about barriers and opportunities to implement virtualisation in reality.

3.2 Emergence

An expected key outcome of the game is discussions among participants about flower quality decay in the game as well as in reality. Eventually the game could lead to cooperation during the game session as well as in reality. The game is designed in such a way to create competition between two chains. This game setting relates to reality and it's aimed to represent market competition.

3.3 Adaptation

After each round, a debriefing takes place where players can share experiences, opinions and coordinate on how to manage quality decay in the next round. Additionally participants can ask questions to the facilitator who can provide information to players.

3.4 Learning

Players learn by experiencing the consequences of agent`s decisions on quality decay at the end of each round, when shops can make decisions according to their satisfaction about the shelf life. Decisions can be for instance to stop buying flowers from a certain provider or ask him/her to pay a fine. Observation of game dynamics, and interaction between players on individual experience during each round can also provide knowledge and learning. At the end of the game a final debriefing with the players allows the game managers to discuss the players' strategies, decisions, and feelings experienced during the game sessions.

3.5 Observation

During the game the facilitator collects data about the decisions made by players and registers them in an excel file. Data collected include the number of flowers sold, the application of spray against fungi (by the producer), the use of protecting covers (by producers and wholesalers) against heat, wind and frost during transport, the storage of flowers in cooling cells (by producers and wholesalers) and the use of a cooling system during transport. According to the collected data the quality decay is calculated (table 2 and 3).

4 Details

4.1 Initialization

At the beginning of the game players will have an initial amount of money and flowers. The amount of money given corresponds to the total expenditures that each player can make during the game play (table 1). In particular, the money given to shops (Small shop, Online shop and Supermarket) corresponds to the amount necessary to buy flowers to cover their own stock. Investment cost of the different players and flower prices have been parameterised to reflect the real business situation in a simplified way. Values have been then adjusted to enhance the playability of the game.

Table 1: Expenditures (in € per 100 flowers) per agent type and total money given to each agent type at the beginning of the game (corresponding to the maximum expected total expenditures). Values have been generated by expert guesses and adjusted to enhance the playability.

	Agent type					
Product	**Producer**	**Wholesaler**	**Transporter**	**Small shop**	**Online shop**	**Supermarket**
Seedlings	8	NA	NA		NA	NA
Anti-fungi spray	12	NA	NA	NA	NA	NA
Water and fertilizer	10	NA	NA	NA	NA	NA
Cooling system	10-20	20-40	100	NA	NA	NA
Protecting cover	50	50	NA	NA	NA	NA
Transport	50	50	NA	NA	NA	NA
Reparation cooling system	100	100	30	NA	NA	NA
Gasoline	NA	NA	5	NA	NA	NA
Check cooling system	14	?	5	NA	NA	NA
Check engine	NA	5	5	NA	NA	NA
Engine reparation	NA	0	200	NA	NA	NA
Cost to purchase 100 flowers	NA	NA	NA	1800	1600	1200
Total expenditures	**256**	**245**	**345**	**1800**	**1600**	**1200**

4.2 Input data

Input data and game dynamics have been developed as the result of interviews with experts in logistics. Interviews revealed the most common causes of quality decay at each logistic step and the main bottle necks in the system. Quality decay is the result of the combination of decisions that different actors make along the chain and it depends from the initial shelf life. In the game flower quality is measured in shelf life days. The initial shelf life is of 17 days and it progressively declines during the game play according to the actors` decisions to: i) spray anti-fungi, ii) store flowers in different cooling chambers (1 °C, 5 °C and 12 °C) and iii) transporting them in a cooled (or not) transport. The initial decision of producers to apply an anti-fungi spray determines the initial vase life after flowers leave the producer (tables 2 and 3). Vase life is further determined by the use of protecting covers against high temperature, wind and frost. If the agent does not use them the shelf life will lower of 2 days in total.

Table 2: Impact of actors' decisions on shelf life days with spayed anti-fungi application by the producer

Actor decision					
	Producer	**Wholesaler**	**Transporter**	**Total**	
Cooled chamber				**Cooled transport**	**Not cooled transport**
1 °C	0	0	-2	0	-2
5 °C	-1	-1	-2	-2	-4
12 °C	-3	-3	-2	-6	-8

Table 3: Impact of actors' decisions on shelf life without anti-fungi application by the producer

Actor decision					
	Producer	**Wholesaler**	**Transporter**	**Total**	
Cooled chamber				**Cooled transport**	**Not cooled transport**
1 °C	-2	0	-2	-2	-4
5 °C	-3	-1	-2	-4	-6
12 °C	-5	-3	-2	-8	-10

5 Conclusions

This deliverable described the first prototype of the "Virtualised chain game" developed in the context of the DaVinc3i project. The game is designed for stakeholders in the flower sector, which play their role in the game: producers, transporters, wholesalers and flower shops.

The game has three main purposes. The first purpose is to make players more aware of events which have an impact on quality decay and hence to encourage a more holistic view of the logistic processes.
In the game as well as in reality quality decay is determined by the decisions and investments made by the different actors (players) in the chain. At the end of each game round if few actions throughout the chain have been taken to lower quality decay, flowers will arrive at the shops with low shelf life. But who`s fault is it? This question arises in a system in which there is lack of transparency.

The second purpose is to show the benefits of virtualisation in monitoring quality decay and its use to maximise logistic processes. In fact via virtualisation the events that cause quality decay are more transparent and hence they can be prevented and/or better managed.

The third purpose is to introduce the necessary steps to virtualise and trigger discussions about possible challenges and solutions. Are all the stakeholders willing to share data with the rest of the chain? Are they ready to invest for a shared goal? These questions are expected to arise in the last game scenario and possibly lead to further collaboration within the chain.

The present version of the game will be tested in the following months via game sessions to test and improve its playability.

5 References

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