

## **DAVINCI<sup>3</sup>I: MOVING TOWARDS RESPONSIVE HUB NETWORK DESIGNS**

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## **Abstract**

The Dutch floricultural sector is generally appreciated for its world leadership; the Netherlands is the flower trading hub for the European market. There are two trends affecting this position. First, virtualisation makes trade flows relatively footloose and flexible. Moreover, it enables the use of better and more information in logistics decision making. Second, internationalisation of markets and production has increased the size of the global market and associated distances. To maintain leadership, the Dutch floricultural sector has initiated the Dinalog DaVinc<sup>3</sup>i project. In this paper we outline the activities we are currently undertaking and some of the outcomes achieved so far. This includes the effects of orchestration in floriculture logistics and the development of a new logistics network model for floriculture logistics. Subsequently we will provide a brief overview of some of the student projects carried out within the DaVinc<sup>3</sup>i project: reasons for outsourcing floriculture logistics in export flows, pooling of inventory by florists and collection of flowers in a small network. Finally, aspects of collaboration for product quality are addressed, as well as recommendations for a cooperative business model for a B2C web shop for plants and flowers.

## **Introduction**

The Dutch floricultural sector is generally considered a global market leader. The five clusters, or *greenports*, are home to the high concentrations of horticultural businesses. The floricultural sector as a whole makes a significant contribution to the Dutch economy in terms of value added and employment (Van der Vorst et al., 2011). Apart from production, trade and logistics are important generators of this contribution as well. Products from around the world are transported to the Netherlands. Here these products are traded, value is added and break/bulk activities take place. For flowers, still over half is auctioned, whereas a quarter of the plants are auctioned.

However, the position of the Netherlands as centre for logistics and trade is not guaranteed. This position is challenged due to two main trends: virtualisation and internationalisation. New technologies are enabling new ways of doing business and controlling logistics processes. These reduce the need for the physical product to follow the same route as the information and transactions related to it do. Expanding production centres in e.g. Africa, as well as new, expanding markets in Central and Eastern Europe are examples of this internationalisation (Van der Vorst *et al.* (2011), Ossevoort *et al.* (2012). The DaVinc<sup>3</sup>i project was initiated to develop innovative logistics concepts supported by an information platform and collaborative business models in support of the Dutch competitive strength (Van der Vorst et al., 2010). As a fundament, we defined the most relevant commercial, logistics and virtualisation scenarios for the different types of supply chains (e.g. retail, detail and e-tail and

flowers vs. plants) (Ossevoort et al., 2012). For these scenarios we (i.e. foremost our two PhD's and two postdocs) are researching:

- the functional specifications for potential logistics coordination, consolidation and collaboration concepts, with particular attention for the design of responsive quality driven logistics networks and synchromodal transport management;
- opportunities for advanced information exchanges and architectures of knowledge bases to facilitate the advanced planning and control concepts developed in the project;
- relevant business models that work for specific settings in open collaboration networks.

In the last two years over 40 students from all three participating universities have conducted Bachelor and Master thesis projects in the DaVinc<sup>3</sup>i project on these subjects. These researches were most of the times collaborative efforts with project business stakeholders, sometimes literature reviews to analyse the state of the art of a specific topic. In this paper we will present some main findings from the last year. Subsequently we will address: the effects of orchestration in floriculture logistics and the development of a metro model for floriculture logistics. Subsequently we will provide a brief overview of some of the other student projects carried out within the DaVinc<sup>3</sup>i project.

### **Orchestration using a hub network in floriculture logistics**

The support for logistics orchestration using a European hub network, one of the underlying ideas for initiating the project, was given by a case for potted plants, see De Keizer et al. (2013). The mixed integer linear programming model that is developed compares different orchestration scenarios and assesses the effects on logistics costs, working times and CO<sub>2</sub> emissions.

The potted plants sector is a subsector of the floriculture sector. The sector consists of about 1,360 Dutch growers, producing around 500 different sorts of plants using 1,930 hectares of land. Furthermore, in 2007 some 1,200 traders facilitate the supply chain – traders can be split up into three groups: wholesalers, exporters and importers. FloraHolland is the main auction where trade between growers and traders is facilitated. Transport is often outsourced to one of the 70 logistics service providers, which in some cases execute additional activities like quality control, handling and packaging. The channels of sales are various and include florists, supermarkets, discounters, as well as garden- and construction centres. Apart from the Dutch sector, local producers also serve demand.

## Scenarios

In our analysis we compare three scenarios. They differ in the degree to which orchestration is applied. Figure 1 graphically summarises the following scenarios:

1. This is the **current situation** or "line network," i.e. without orchestration. Products are either transported directly between countries and sales outlets or sourced and delivered locally (local-to-local flows)
2. In this scenario network orchestration is implemented via the **use of hubs**. Potted plant flows between supplier- and customer regions are now coordinated. Instead of direct deliveries the products are now transported from Dutch hubs via European hubs to market outlets. However, there is still limited coordination within the supplier regions (that supply the Dutch hubs) and within the customer regions (delivery from the European hubs to customers).
3. In this scenario network orchestration is extended to include **consolidation of product flows**. This applies to both product flows in supplier and customer regions. This implies that different types of suppliers, respectively different types of customers, coordinate their logistic activities resulting in consolidated product flows.

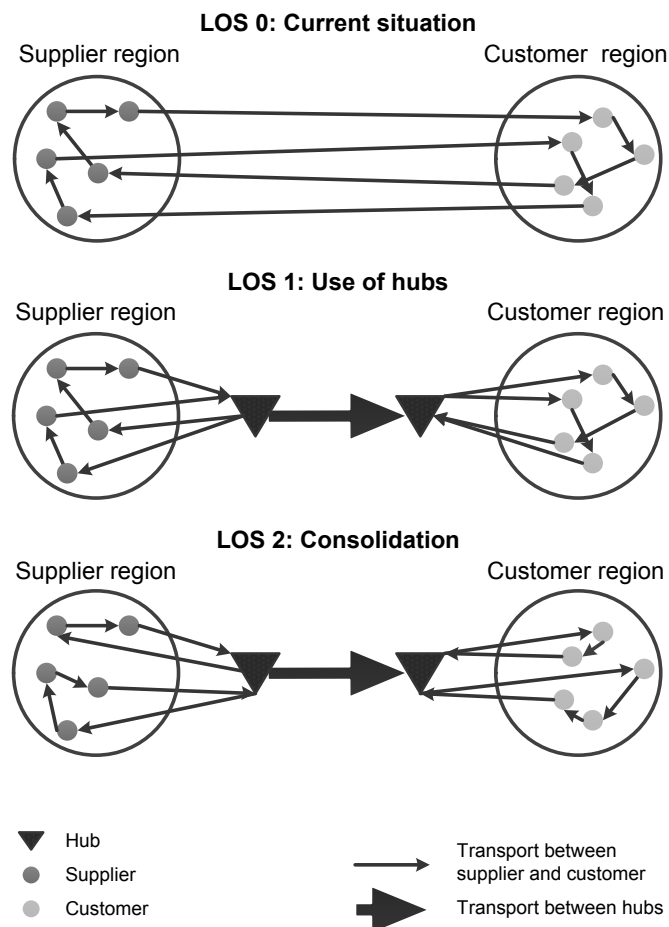


Figure 1. The three logistics orchestration scenarios (LOS) in the potted plant sector.

## Data

Like in all model studies, multiple assumptions had to be made to capture the system in the model. On the one hand this had to do with the system boundaries, on the other hand with data availability. For example, first the yearly supply and demand volumes are based on national production, consumption, export and import figures. If available, exact figures are used, otherwise estimations are made, for example, based on number of inhabitants. Second, hub locations are chosen based on the following criteria: three current Dutch auction locations, locations close to main residential areas in Europe, and locations close to upcoming areas of production and consumption. The costs are equal for all potential locations. Third, we have considered only one transport mode (trucks), therefore we convert kilometres to CO<sub>2</sub> equivalents using a standard classification factor.

## Effects

The impact of the different orchestration scenarios can be seen in table 2. It shows that redesigning the network, thus with hubs and with consolidation between the hubs, decreases costs by 19%. This is mainly due to time savings because long transportation routes in the current situation are split into routes to and from a hub. Consolidating flows in the supplier and customer regions adds another 9% cost decrease, due to a better load factor of trucks, resulting in both less truck kilometres, and thus CO<sub>2</sub> emissions, and transport time.

Table 2. KPIs for different orchestration scenarios (current situation = 100)

	KPIs			
	Hubs	Costs	Time	CO <sub>2</sub>
<b>Current situation</b>	-	100	100	100
<b>Scenario with hubs</b>	15	81	73	91
<b>Scenario with hubs and consolidation</b>	15	72	62	80

Table 22 shows some detailed costs contributions for different legs in transport. Looking in more detail, we find that distribution from hubs to customer regions takes more than half of the costs. As such, consolidation in distribution has larger benefits than consolidating in collection. Consolidating both is challenging as it requires collaboration between all European actors. Consolidation in the Netherlands only does not create a significant decrease in kilometres and time given the proximity and the importance of the German market. The rather high load factor of trucks to the retail outlets limits the opportunity for consolidation in that part. Consequently, consolidation at all levels in the supply chain is needed to really gain some benefits.

Table 3. Cost share of different network segments for different levels of consolidation

	Cost index	Cost shares				
		Supplier region	Supplier to hub	Hub to hub	Hub to customer	Customer region
<b>Consolidation between hubs (LOS 1)</b>	81	26%	16%	8%	22%	28%
<b>Bundling collection &amp; distribution (LOS 2)</b>	72	22%	18%	9%	25%	26%
<b>Bundling distribution</b>	77	27%	17%	8%	24%	24%
<b>Bundling collection</b>	76	21%	17%	8%	24%	30%
<b>Bundling collection NL</b>	80	25%	16%	8%	23%	29%
<b>Bundling only retail distribution</b>	80	26%	16%	8%	23%	27%

### **There is a potential for orchestration of logistics**

This example from the potted plants sector shows the potential there is in applying logistics orchestration concepts. Bearing this in mind, we are now furthering our research in this area by, for example, including more accurate measures of responsiveness and including product quality decay for flower distribution. However, we also show that successful orchestration can best be realised if implemented on a European scale. To this end we will be researching the ground rules of building an orchestrated logistics network in the remainder of the project.

### **Exploring the concept of a metro model for floriculture logistics**

*To develop an innovative approach to floriculture logistics, we are conducting research into the metro model, a new approach to distribute plants and flowers from grower to consumer (Theeuwen, 2013). The principle of the model is that plants and flowers from across the globe are delivered to the store or consumer in the way that is most efficient for each bouquet or plant. In addition, shipments of different shippers may be combined if needed to achieve efficiency. This contrasts to the current approach where the bulk is transported on fixed routes using set schedules as arranged by individual shippers. The model takes into account constraints in terms of cost, lead time or environmental preferences. Synchronodal connections between hubs in the network are executed as per a fixed schedule. The network of a metro model is shown in figure 2.*

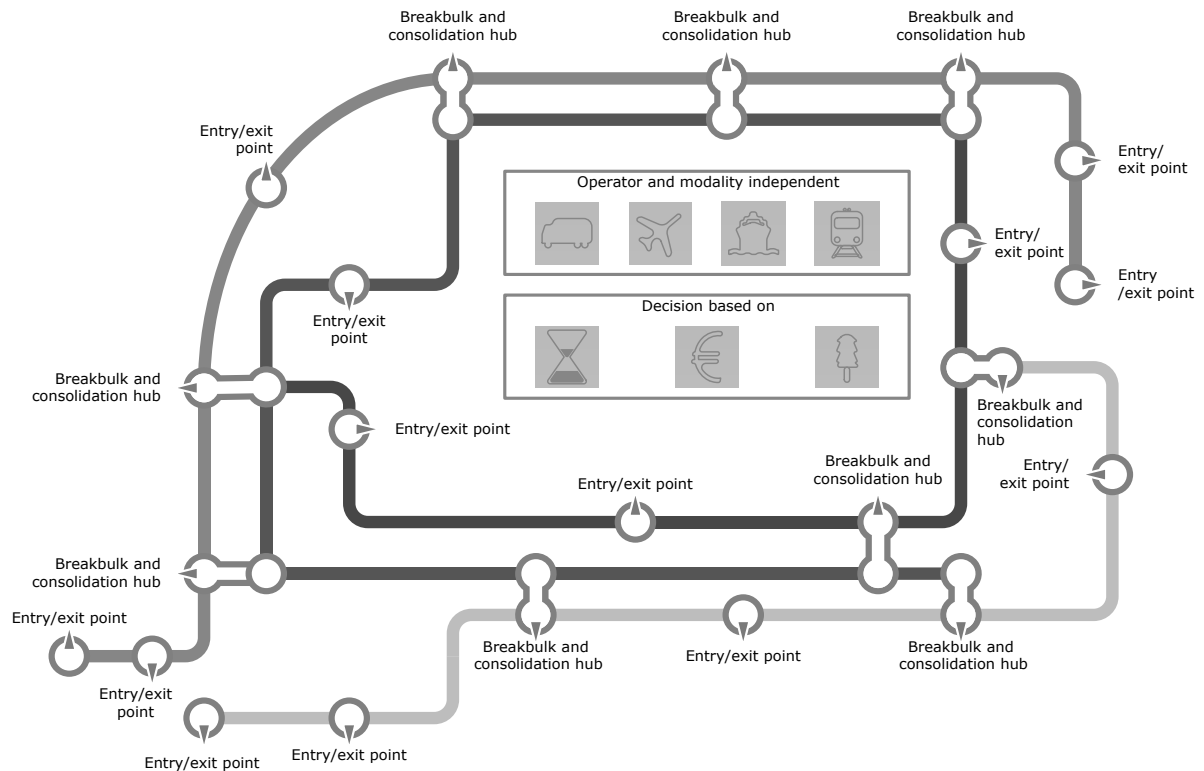


Figure 2. Graphical depiction of the concept of a metro model

### Basics of the metro model

The model assumes inbound hubs, as well as clustering hubs. At the former, plants and flowers enter the network (after leaving the grower for example), at the latter, bouquets or pots are prepared. This flow from a logistics point of view is depicted in figure 3. In this first study (Theeuwes, 2013), we only considered a small share of the European market with the scope limited to a subset of the region around big cities. Likewise, in terms of production areas and width and depth of the assortment simplifications were applied as to be able to develop a conceptual model. The scope is limited to:

- 10 cities and 10 clustering hubs in only six countries: the Netherlands, Belgium, Luxembourg, Germany, France and the UK
- The 10 most common products (at the level of roses, gerbera, etc. – this excludes (sub) varieties)
- There are in total 13 sourcing locations across the world
- Products from growers are received at 10 only inbound hubs

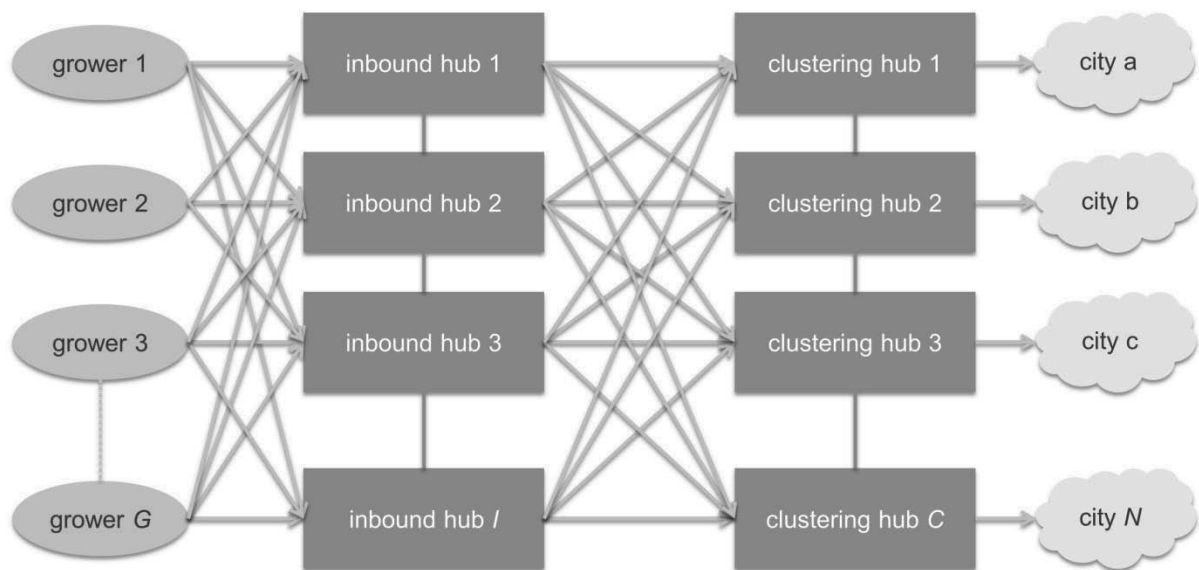


Figure 3. The flow of products in the metro model

## Effects

In this exploratory study we investigated whether the metro model works in principle. Three KPIs were used to assess the potential of the metro model. As there is no accurate baseline scenario, an approximation of the current situation was modelled assuming the same two minimisation objectives (lead time and costs) are used for the metro model. *Table 4* shows the outcomes of the simulation. A few findings stand out. First, the costs of delivering bouquets does not decrease when lead times are minimised. Second, lead time does decrease by around 10 to 30% vis-à-vis the current situation. Whether the metro model will improve environmental performance is unclear: the simulation shows an increase of emissions when lead time is minimised. However, emission are reduced if costs are minimised, due to a preference for slow, but cheap modes (i.e. train).

It has to be borne in mind that this first study looks at the metro model with a limited scope. Value Added Logistics were largely left out of scope in terms of costs and time. In additional research steps, we will explore the allocation of these activities to hubs, as well as the location of hubs to determine, amongst others, the optimal level of (de)centralisation of VAL activities. Other next steps include the inclusion of a wider and deeper assortment, the possibilities for strategic product positioning and the last mile.



Table 4. Performance of the current situation and the metro model (values per bouquet)

Scenarios	Minimise lead time			Minimise cost			
	Current situation	Metro Model		Adjusted Situation	Current	Metro Model	
		Value	Index			Value	Index
<b>Transportation cost (euro)</b>	€ 0.87	€ 0.87	100	€ 0.73		€ 0.70	86
<b>Average Lead time (hours)</b>	9:45	6:30	66	10:00		8:15	92
<b>Emissions (gram)</b>	0.45	0.47	106	0.06		0.05	79

## Other student research

Apart from these two studies, many more studies have been conducted by students in collaboration with businesses or are still underway. In this section we highlight the findings of some of the completed studies.

### Logistics studies

#### *Reasons for outsourcing logistics and transport*

Weiss et al. (2013) investigated the reasons for foreign traders to take responsibility for logistics and transport in own hands. These reasons may provide indications whether there is scope for taking (more) control of the logistics of foreign clients. Table 5 we highlight the findings. In essence, there is sufficient ground to orchestrate outbound logistics as providers.

#### *Inventory pooling by florists*

One of the recommendations of the benchmark, as executed in 2012, was to explore opportunities for consolidating the stocks held by florists (Ossevoort et al., 2012). At present, each florist takes care of his own supplies and inventory. This potentially leads to higher inventory levels and waste than would be possible if florists were to share inventories. This year we conducted a study into this idea where, from a theoretical point of view, the potential was explored. The test case concerned only two florists with a limited demand for flowers. The three parameters that have been considered are the ordering costs, the profit margin and the variability of demand. The outcomes are shown in table 5, the findings show potential and therefore a real-life case is now being initiated.

#### *Collection of flowers in small networks*

In a small cooperation of growers of high-quality products, a student has researched different scenarios for the collection of flowers. These growers supply to a hub in nearby Naaldwijk from which the flowers are pushed further into the supply chain. To optimise the supply chain and provide the

actors in the supply chain with sufficient time to process orders while maintaining order cut-off times, new collection regimes where being considered. These include (Oorbeek, 2013):

1. collection by a jointly contracted Logistics Service Providers (LSPs) with a fixed route
2. collection by a LSP contracted by the individual growers
3. self-delivery by the individual growers to the hub
4. self-delivery by the individual growers to their colleague with the largest order on that day
5. a flexible scenario whereby a threshold value must be exceeded to secure collection by a jointly contracted LSP, otherwise the grower will deliver the products to the hub himself

In an industry where improvisation and quick solutions have been prevalent for a long time, this study has delivered valuable insight to the growers.

*Table 5. Identified reasons for outsourcing logistics and transport (Weiss et al., 2013, He, 2013, Oorbeek, 2013)*

<b>Reasons for (not) outsourcing logistics and transport</b>	<b>Inventory pooling by florists</b>
<p>Outsourcing:</p> <ul style="list-style-type: none"> <li>• Difficulties with realising sufficiently high truck loads</li> <li>• Cross-border issues (corruption)</li> <li>• Higher costs</li> </ul> <p>In-sourcing:</p> <ul style="list-style-type: none"> <li>• Ability to control (product) quality</li> <li>• More control over lead-times</li> </ul>	<ul style="list-style-type: none"> <li>• It is possible to significantly reduce inventory levels, while roughly maintaining profit levels</li> <li>• Costs associated with ordering have a significant impact on expected profits</li> </ul>
<hr/> <p><b>Collection of flowers in small networks</b></p> <hr/> <ul style="list-style-type: none"> <li>• Individual contracting of logistic service providers is the cheapest, but least sustainable option</li> <li>• Self-delivery by growers to the largest grower of the day (from which products are further distributed) is the most expensive and relatively polluting solution</li> <li>• A jointly contracted LSP takes most time, but is the most sustainable solution. The costs are average compared to the other options as discussed in the concerned section above</li> </ul> <hr/>	

#### *Studies on business models in collaboration*

Two studies stand out where it comes to collaboration. This includes an cooperative of breeders aiming to achieve a consistent high quality of flower bulbs and a cooperative consumer webshop for flowers.

#### *Collaboration for quality*

A cooperative of breeders and growers has a unique variety of flower bulb which they direct aim to deliver to the market with a consistently high quality (Vredevoort, 2013). As is common in the floriculture industry, the cooperation is largely based on trust and has been formalised to a limited extent. The seven breeders form a fairly close cooperation sticking to the objectives of the cooperation. The 21 growers, however, do not always act in line with the agreements. This is due to

market incentives, such as certainty regarding sales or an attractive financial offer. The recommendations of this research are shown in table 6.

*A cooperative business model for a webshop*

In two of the DaVinc<sup>3</sup>i scenarios (see Ossevoort et al., 2012) we assume online sales to be dominant vis-à-vis retail and detail. This will require the industry to develop new business models to serve on line customers. Assuming the industry leads the way and does not wait for a third party to develop this market, we have conducted a study to understand how the industry should develop a cooperative business model. One overall conclusion of this research is that from the perspective of the industry it would be best if the webshop is a service provider which does not own the products (Mello, 2013).

*Table 6. Recommendations on enhancing business models in cooperation (Vredevoort, 2013)*

<b>Collaboration for quality</b>	<b>A cooperative business model for a webshop</b>
<ul style="list-style-type: none"> <li>• Shift focus from <i>trust</i> primarily to include more <i>formal arrangements</i>, this will also create opportunities for 'checks and balances'</li> <li>• The grower cooperative should be the <i>orchestrator</i> to maintain quality, not intermediate wholesalers</li> <li>• Interdependence between breeders, growers and wholesalers will support the success of the cooperation</li> <li>• All parties involved in the cooperation should communicate clearly regarding their interests and objectives</li> </ul>	<ul style="list-style-type: none"> <li>• Persuasion and creating a sense of appreciation are needed in a relatively conservative industry</li> <li>• The front-end should not focus on a one-size-fits-all solution, leaving room for cooperation between a sub set of players</li> <li>• However, the front-end should provide a comprehensive offer opening new potential partnerships</li> <li>• Perceived value drivers are not necessarily actual value drivers (e.g. the notion "direct from source" is less relevant than actual vase life), which may leave space for cooperation</li> </ul>

**Conclusions and outlook to 2014**

As can be concluded from this paper, a variety of topics is being researched. Some of the studies are more fundamental and innovative, whereas others are more applied and practical.

The potential of a hub network has been clarified with a case from the potted plants sector. Within the limitations of the study, the potential has been shown to be significant. Further research in to hub networks is now taking place. This includes the question of the allocation of Value Added Logistics and the use of real-time information to increase the responsiveness of logistics. Moreover, the specific application of the metro model is also being investigated further with three more studies already planned. This are studies into the allocation of VAL activities in the network, the decision criteria for hub locations and a model to allocate products flows to transport links in the network.

Apart from these network design issues, we will also investigate both offline and online planning in synchronomodality. Such planning methods should enable LSPs to develop robust synchronomodal transport solutions. This links directly to the research into the metro model, where links are serviced

by different transport modes at set schedules. More insights in the challenges and benefits of such planning methods may be expected in 2014 and 2015.

Cooperation studies have shown both the need to the "hard" aspects of cooperation, as well as the "soft" aspects. Examples of these aspects include contracts, "checks and balances" and interdependence and inclusion of suppliers. Studies have shown that certain preconditions for successful cooperation do exist already. Trust, often cited as crucial, is generally present. However, as the case of collaboration for quality shows that an excess of trust cannot be relied on and "hard" aspects also need to be present. Next year we will investigate more cases of cooperation of logistics concepts and conduct a large scale survey of cooperation models.

An equally important part of the project is the description of an IT platform facilitating the exchange of information between supply chain partners. The outlines of this platform have been described in Cor Verdouw et al. (2013). At the moment we are researching and developing two pilots that focus on the use of information in logistics. The first pilots concerns a so-called Virtual Quality Monitor which allows for real-time management of product quality. The second pilot concerns logistics monitoring and (re)planning based on timely quality info, this pilot is currently in development.

We hope to have demonstrated that DaVinc<sup>3</sup>i is a challenging and innovative project where science and practice meet. This bird eye view has only provided limited information on each of the subprojects, hence we invite all those interested to contact us to receive more detailed information but especially to help us further develop the sector to move towards a responsive hub network design.

## **Acknowledgement**

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