

A conceptual framework for data-driven logistics in Fruits & Vegetables supply chains

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Introduction

- Presentation 35 minutes
- Q&A 10 minutes
 - Please use the chat for questions
- Presentation will be in English
- Slides will be made available



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Senior Research Supply Chain Development

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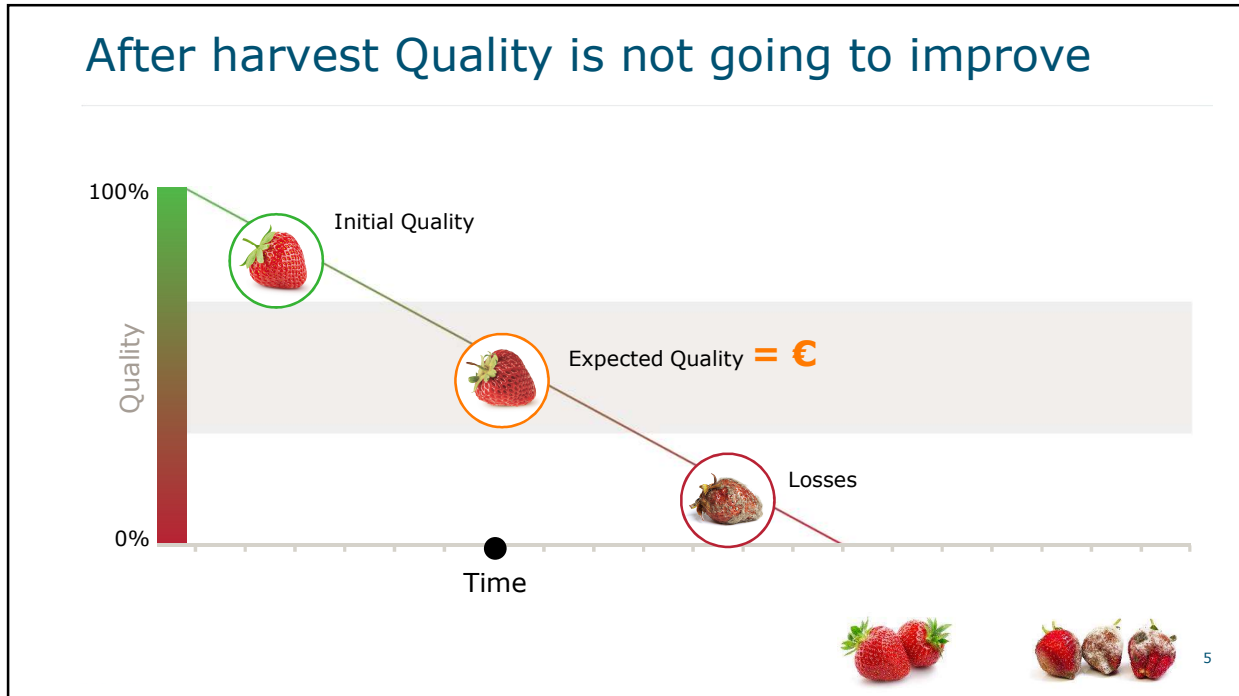
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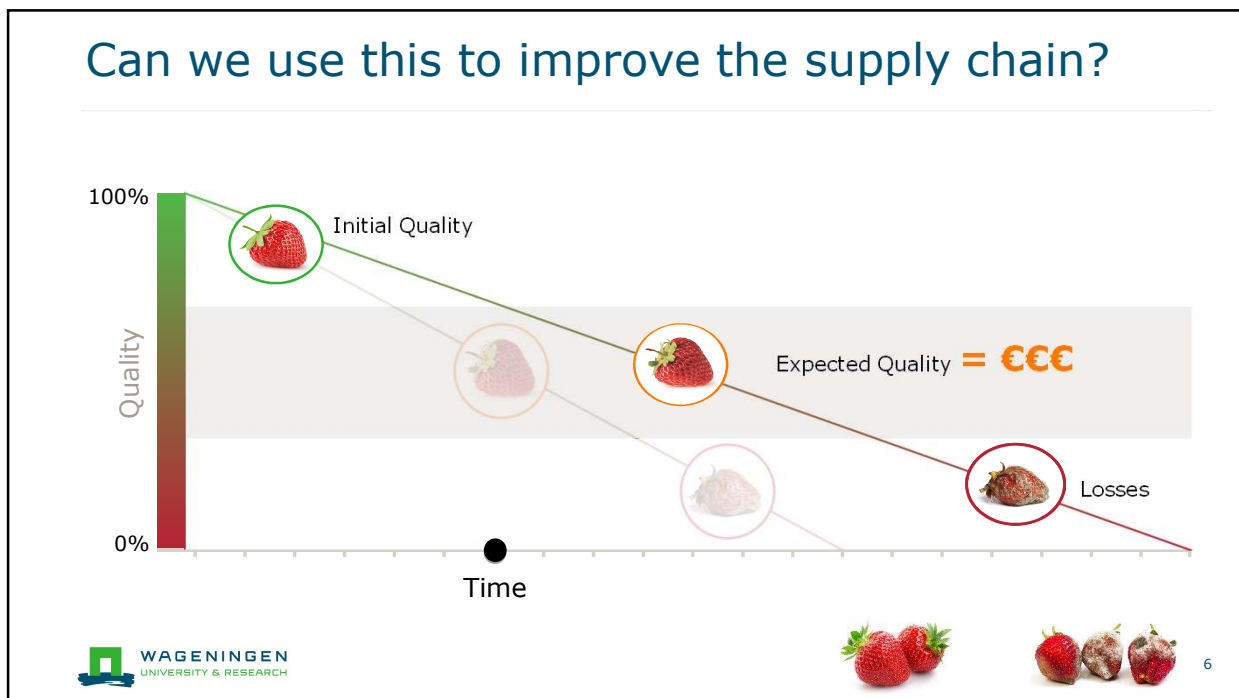
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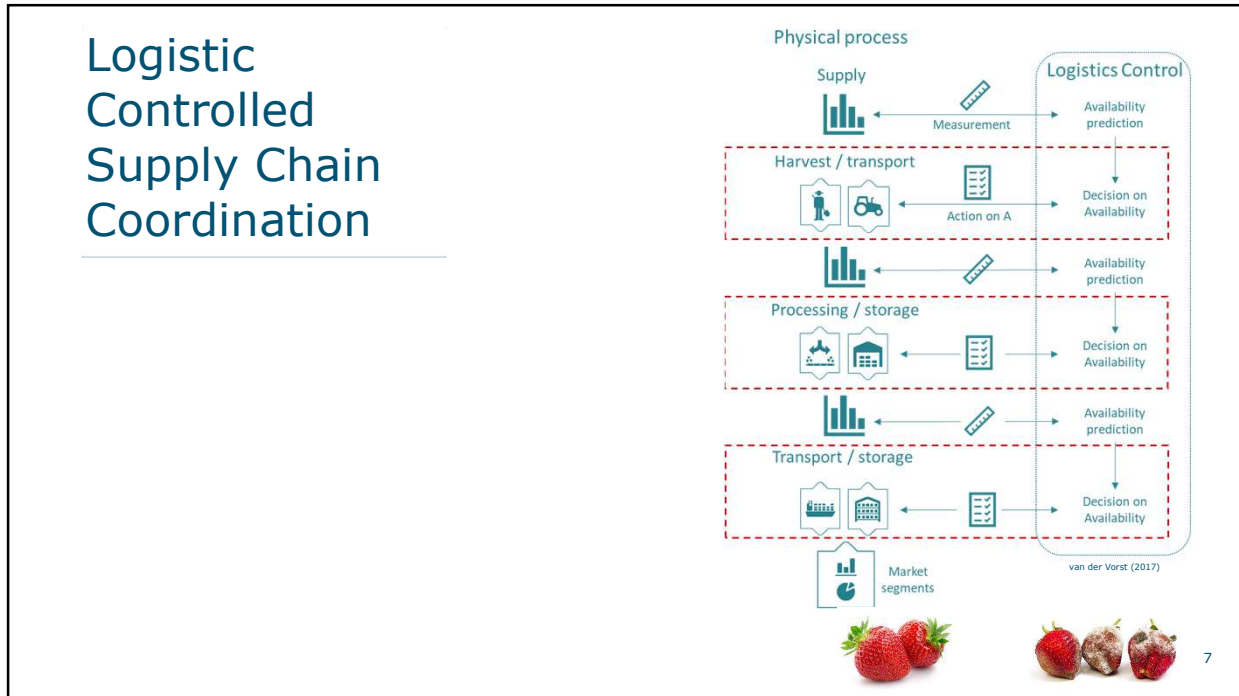
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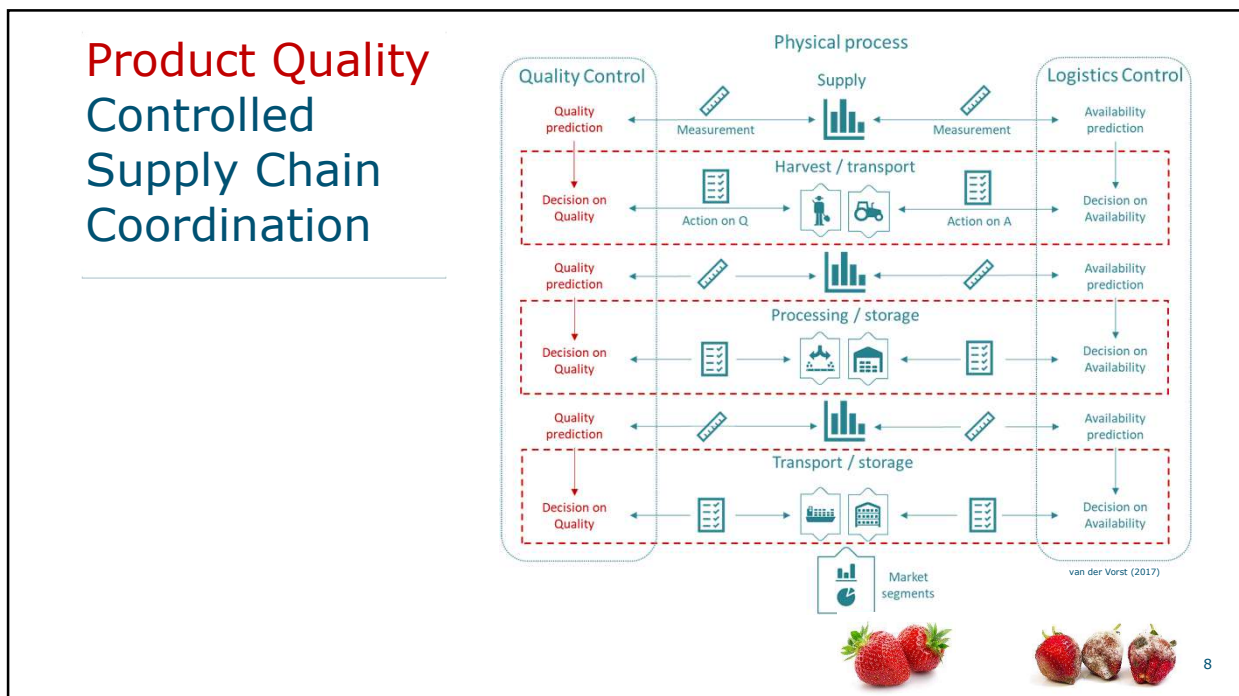
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Product Quality Controlled Supply Chain Coordination

We know that fresh food supply chains have a very high risk of **product quality degradation**.



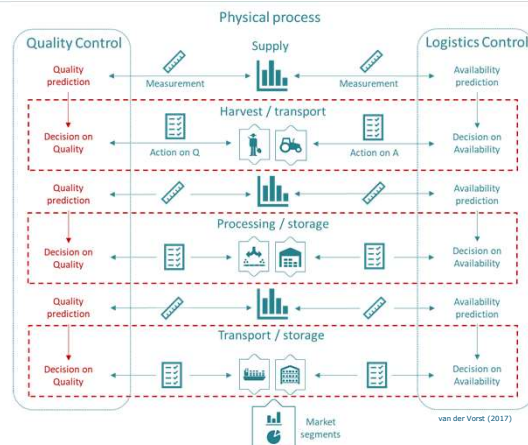
We can **sense, predict and control** product quality in each step of the supply chain.



We could control fresh food supply chains in a proactive manner and better **reshape networks –even during transport–** to match initial product quality with the final customer's (individual) requirements.



Therefore we need collaborative and integrated data-driven network decision-making.




Relevant research: NWO project IoT4Agri


- Quality Controlled Logistics in IoT-enabled Perishable Supply Chains = *IoT4Agri*
- Applying quality sensors and IoT in the fruits and vegetable supply chains
- Moving van cold chain logistic controlled to **data-driven product quality** controlled supply chain coordination



Business relevance




Johan Kruijse
R&D Manager




van Oers
UNITED
delivering excellent produce
part of AGRIAL

“ We want better **control** over the post-harvest supply chain and **guarantee high quality products**, within reasonable costs. We believe IoT can help and we want to explore how! ”




Arthur van der Knaap
R&D Manager




EURO POOL
SYSTEM

“ Our customers want to manage and **control the conditions** of fruit and vegetables throughout the supply chain. We want better **visibility** of our assets. We want to explore the business case of **embedded sensors** in our crates and pallets ”

“Ethylene sensing during transport is currently expensive and cumbersome. The combination of miniaturizing Gas Sensor Technologies and IoT may overcome these problems. We want to **speed up our development** in this area ”




Jan-Kees Boerman
Managing Director




EMS

“ We want to **help the logistic sector** to pick the cherries of the **digital transformation**. IoT promises huge benefits for perishable supply chains, but requires flexible, collaborative solutions ”



Gerwin Zomer
Programme Lead
Data Driven Logistics



TNO

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Sustainability relevance

World Vegetables Map (2018)

World Fruit Map (2018)

Source: research.rabobank.com



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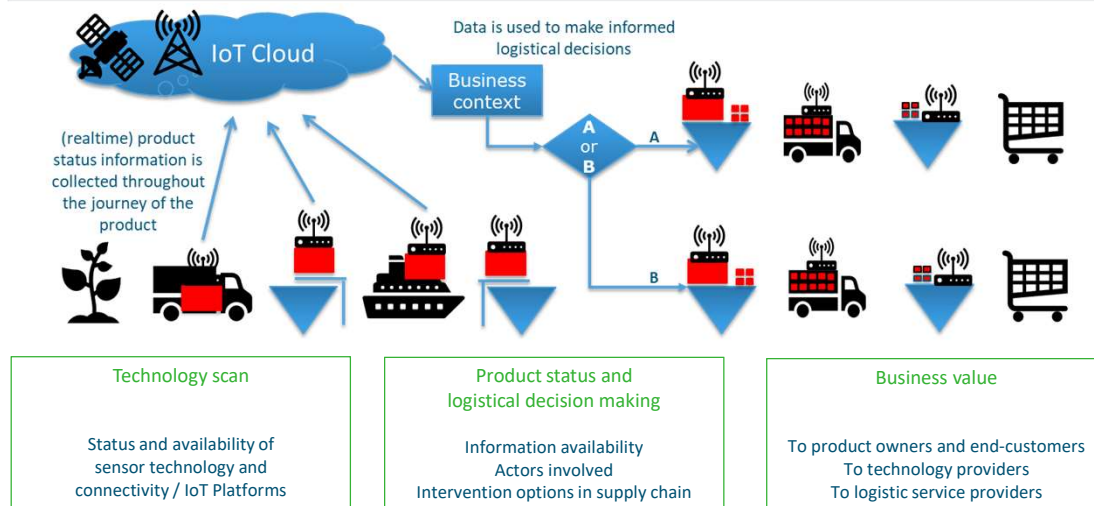
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The basic idea = IoT4Agri



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From cold chain logistics to Data-driven quality-controlled logistics

■ Cold chain logistics:

- Refrigerated technology and equipment focus
- Passive static management
- Small room for logistic optimization
- Traditional IT infrastructure is adequate

■ Data-driven quality-controlled logistics:

- Data analysis focus
- Active dynamic management
- Larger room for logistic optimization
- 5G or 6G IT infrastructure is desired

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The crucial role quality-sensor can play in the data-driven Fruit and Vegetable supply chains

- Sensing and recording the environmental parameters for the products
- Predicting the remaining shelf life with the quality-decay models
- Real-time data transmission to the central control platform
- Logistic optimization based on the real-time product-quality data



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Traditional quality control vs Sensor-based quality control

Traditional quality control:

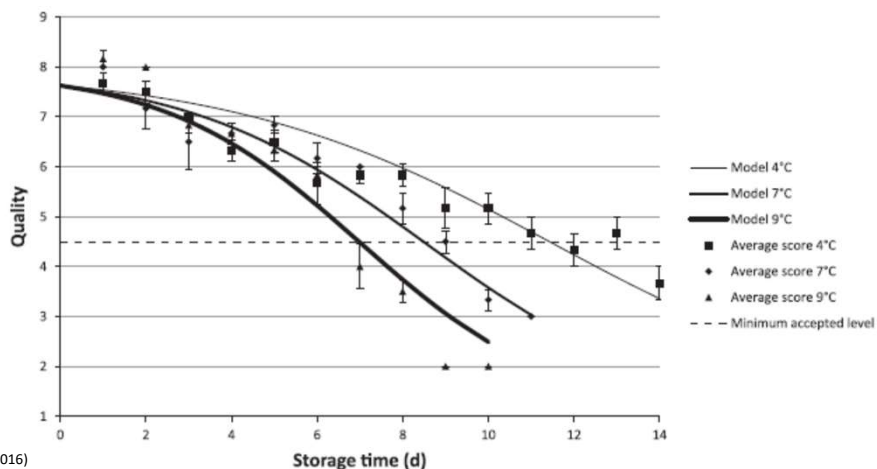
- Data collection at the milestone time points
- Delayed data communication
- Relying on expert experience

Sensor-based quality control:

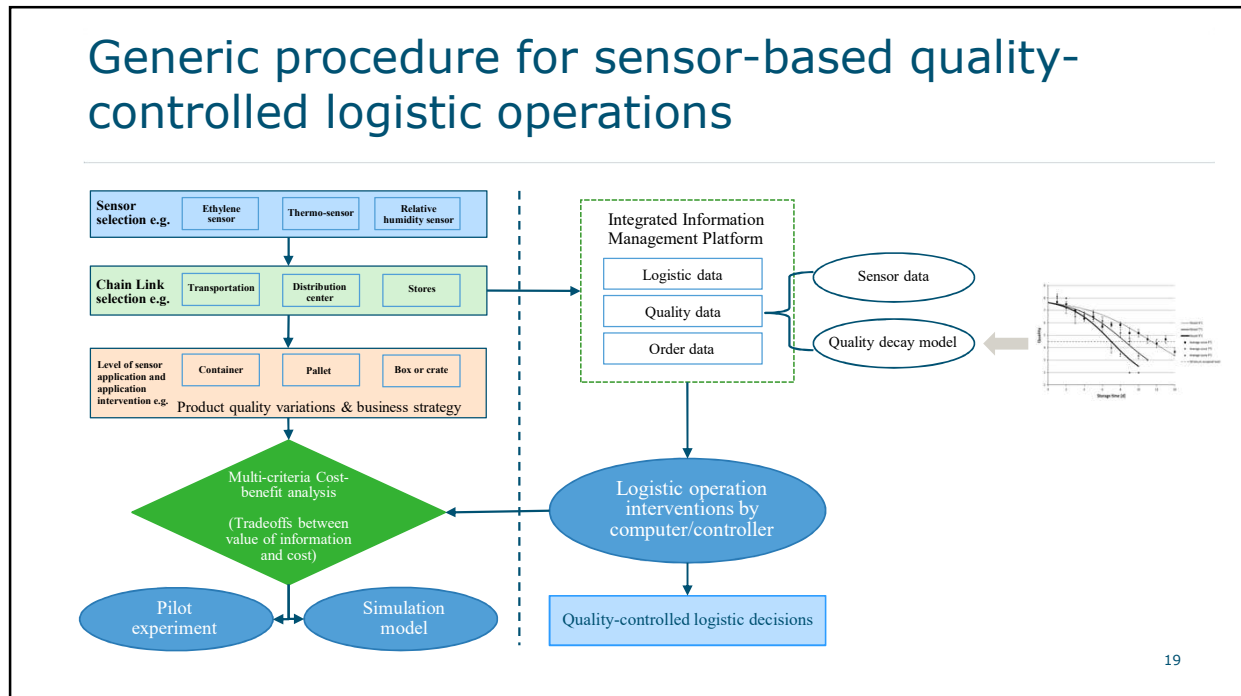
- Continuous data collection
- On-time data communication
- Reliable **quality-decay model** is the key

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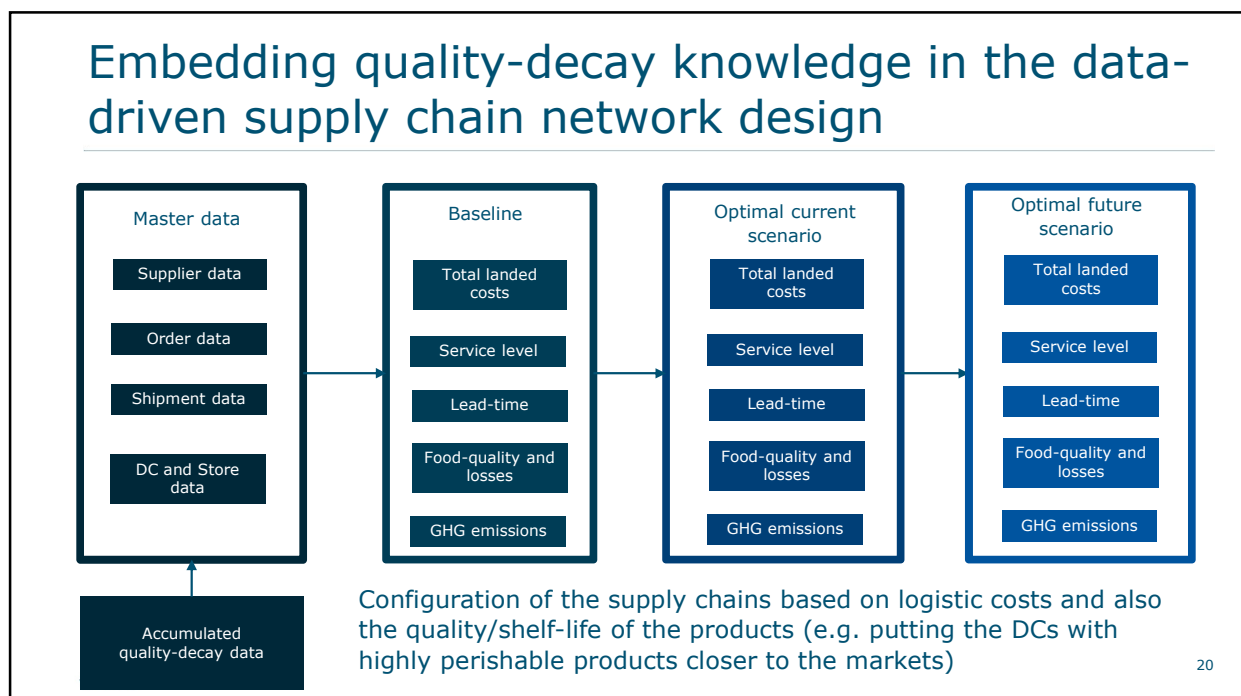
Quality-decay models



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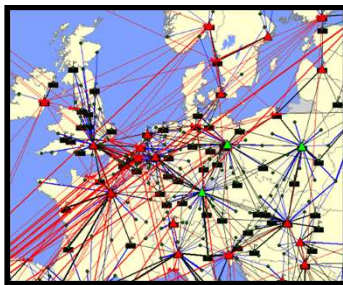
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Comparison of different distribution network designs

Centralized Scenario

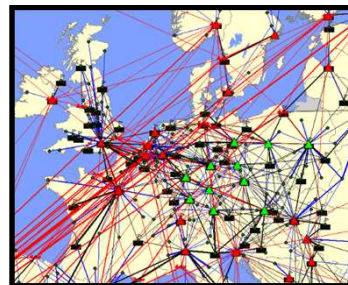


Normalized KPIs:

Costs 160
Closeness to the market: 830
Inventory level: 65
FLW percentage: 3%
GHG emissions: 130
Service level: 86%

Product quality at the consumer end: 92

Decentralized Scenario



Normalized KPIs:

Costs 110
Closeness to the market: 450
Inventory level: 90
FLW percentage: 5%
GHG emissions: 80
Service level: 98%

Product quality at the consumer end: 96

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Business opportunities

- Maximize product quality by remote control on conditions according to real-time product situation
- Optimize the order of product issuing (First Expired First Out)
- Redirecting the goods flows to different markets based on product quality information (New markets & market differentiation)
- Determine the optimal stock levels in DC's and stores based on product quality
- Lower the food loss & waste in DC's and stores
- Lower the energy consumption and CO₂ emissions
- Accelerating the supply chain based on the anticipated product quality:
 - (Extra) service at port / fast track
 - Process speeding up at trader / cross docking
- Selecting the transport modality based on the quality of the products
- Selecting the locations of DC's and facilities based on the long-term average quality/shelf-life of the products in the strategic network design

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Standard, trust, and resilience

- Set up quality reference standards for Fruits & Vegetables
- Improve the trusts between chain players for data sharing
 - Data privacy protection
 - Fair rewarding scheme
- Improve the resilience for digitalized supply chains
 - Retain human interventions to some extent even though full automation is possible.
 - Backup systems

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Questions?

Answering questions from the chat



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Question & Answer

Question

- (How) do you take into account the uncertainty of your prediction of the quality into the logistic optimization? Or do you optimize based on your most 'negative' prediction that you expect?

Answer

- The biological varieties of the F&V products are the major source of the quality uncertainty when performing logistic optimization.

Solutions include:

- Applying the modelling techniques that calculate the quality of products within a batch as a distribution instead of using a mean to represent the quality of the batch
- Applying the sensors to the lower-level of units such as crates or boxes or even individual products; however, the costs will be increased significantly
- Reducing the biological varieties by purchasing the products from the professional farms that have more uniformed product quality; or sorting the products with similar qualities into to the same batch to reduce the quality variances within batches

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Question & Answer

Question

- If the quality of the strawberry in a truck is detected to be (slightly) worse by the sensors, could you name the logistical changes that should be done?

Answer

- Modify the conditions of the storage or transportation to prevent further quality decay
- Change the best-before or expiring date accordingly
- Change the shipment destinations if possible (e.g. shipping to the local DC instead of the central DC)
- Mark this batch of strawberries as the high-priority products to be issued as soon as possible
- Propose appropriate discounts to accelerate the sales of the products
- If the quality is not acceptable by the original market anymore, then redirect the strawberries to the closest market or outlet which has lower quality demand.

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Thanks!

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