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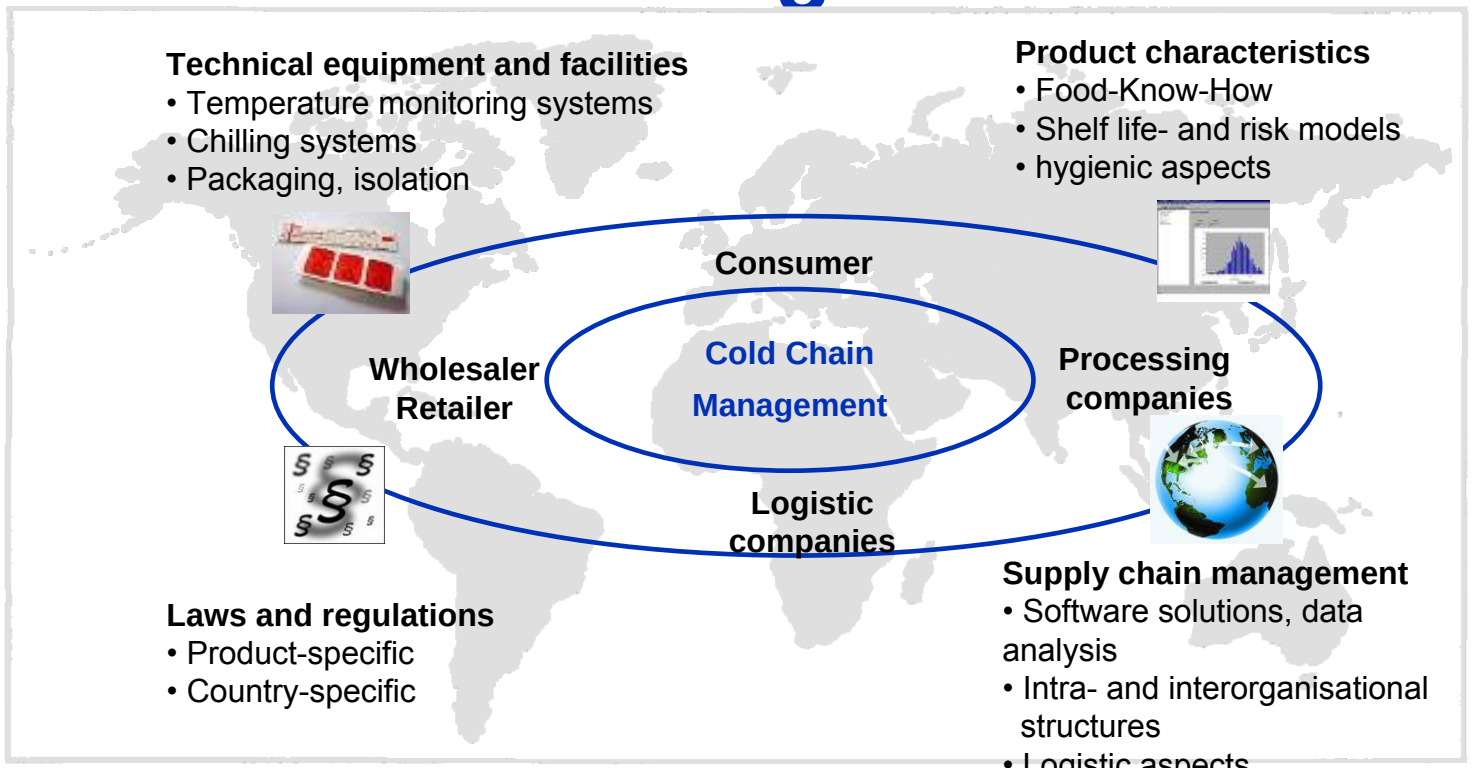
Innovative tools supporting Cold Chain Management



“Waste is money – make the world a better place ”

Luxemburg, 04.05.09

Dr. Judith Kreyenschmidt

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Contents

1. Introduction Cold-Chain-Management Group, University of Bonn

2. General problems regarding cold chain management

3. Tools to support CCM and reduce waste
   - temperature monitoring equipment
   - shelf life modeling

4. Factors keeping in mind by the integration of innovative tools

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Cold Chain-Management Group (CCM Group)

Coordinator Dr. J. Kreyenschmidt

Institute of Animal Science

Preventive Health Management

http://www.ccm.uni-bonn.de

Institute of Animal Science

Preventive Health Management Group

Professor Dr. B. Petersen

http://www.itw.uni-bonn.de

Institute of Agricultural Engineering

Household Technology Group

Professor Dr. R. Stamminger

http://www.landtechnik.uni-bonn.de

Institute for Nutrition and Food Technology

Food Technology and Biotechnology Group

Professor Dr. B. Kunz

http://www.iel.uni-bonn.de

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Cold Chain-Management Group

www.ccm.uni-bonn.de

Institute for Agricultural Engineering:

Development of concepts to improve food safety & quality in private households.
Investigation of consumer habits and practices with refrigerators and assessment of its influence on cooling capacity and energy consumption

Institute for Nutrition and Food Technology:

Development of technical solutions to improve food quality and safety
Development of methods to prolong shelf life of perishable foods

Institute of Animal Science:

Development of **shelf life models**
Investigation of **innovative systems** in the field of Cold Chain Management and cold storage e.g. time-temperature-indicators
Development of methods to **characterize meet freshness**
Investigation of **anti-microbiological** properties of materials to improve food quality
Coordinator of **international workshop and network Cold Chain Management**

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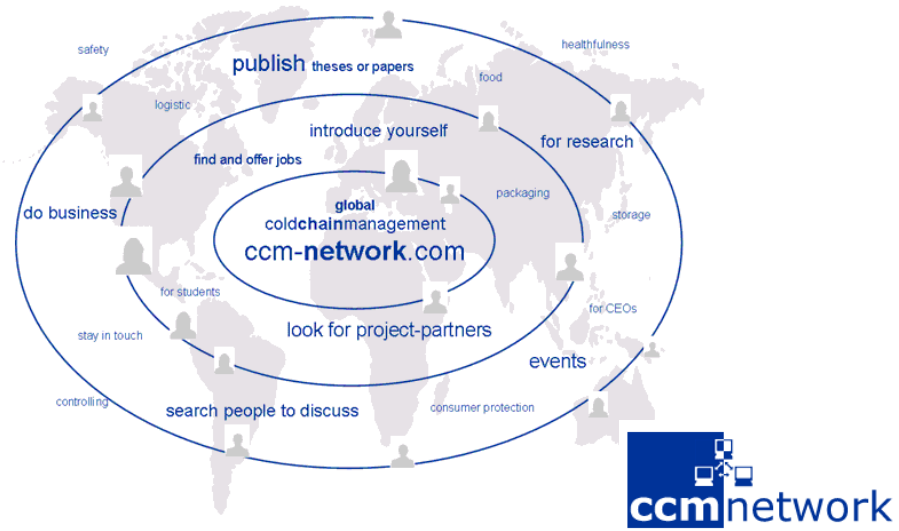
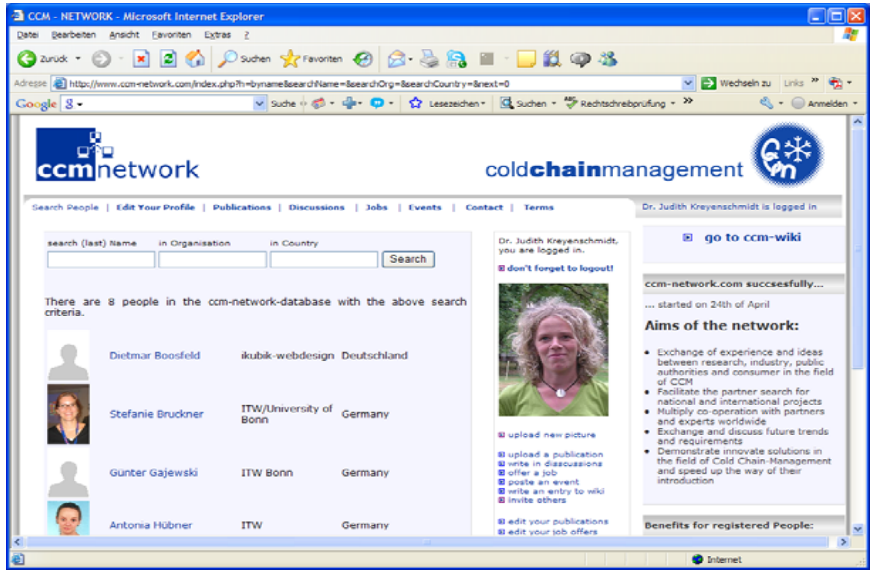
Network Cold Chain-Management

www.ccm-network.com

Communication platform for exchange of experiences and ideas between research, industry, public authorities and consumer in the field of CCM



ccmnetwork



- Facilitate the partner search for national and international projects
- Multiply co-operation with partners and experts worldwide
- Exchange and discuss future trends and requirements
- Demonstrate innovative solutions in the field of Cold-Chain-Management and speed up the way of their introduction

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General problems regarding cold chain management in meat supply chains

- Monitored temperature data are often not meaningful
  - in meat supply chains often environmental temperature is recorded which can differ significant from the product temperature in dependency fro m the packaging material, placement of the temperature monitoring system
  - temperature variations during transportation or storage are often not considered

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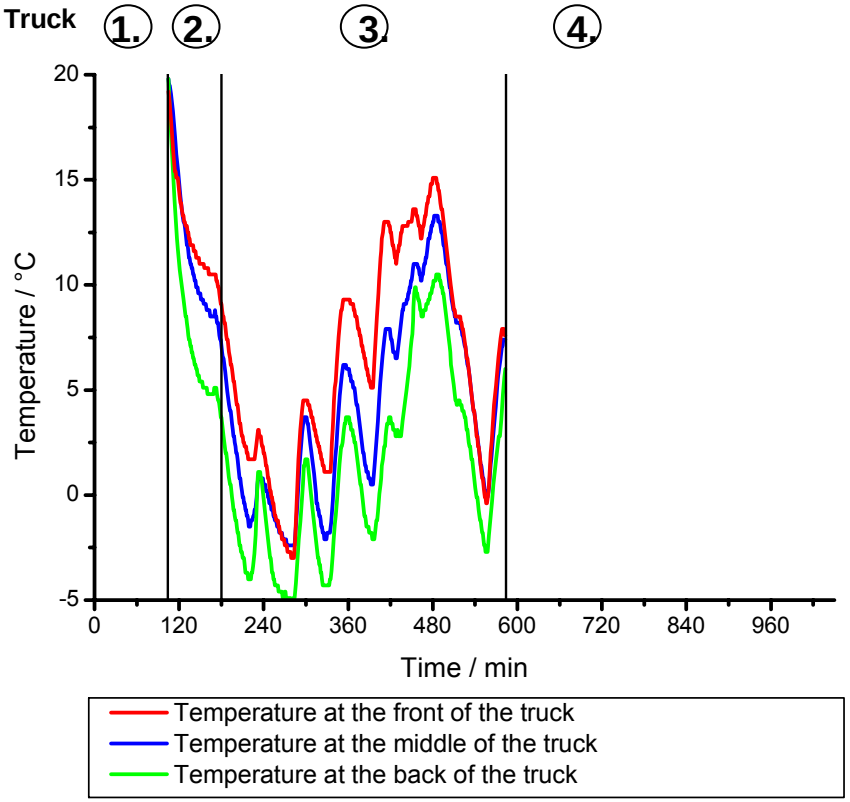
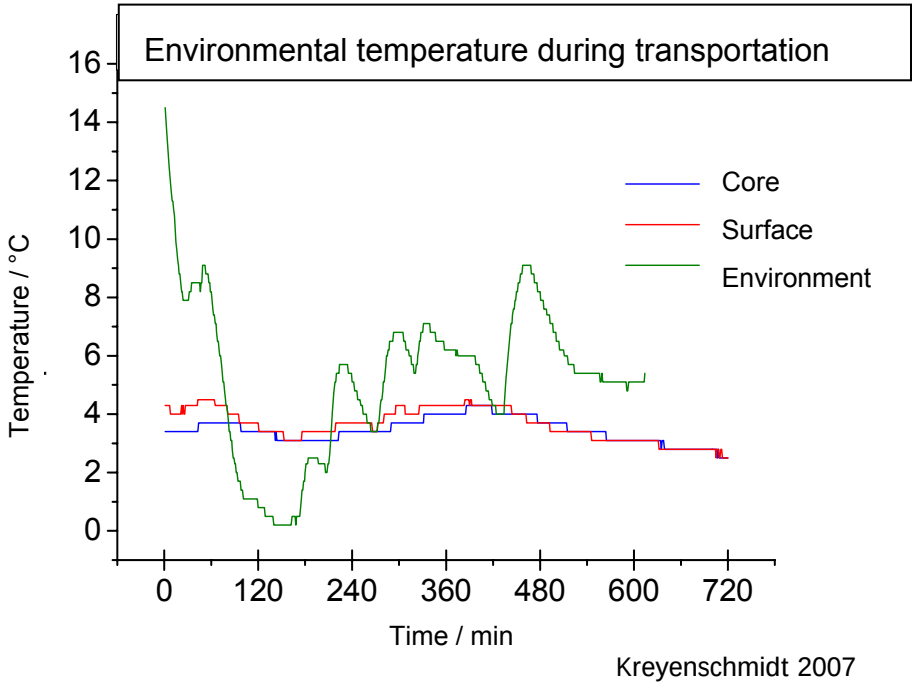
Temperature conditions in the food chain

a) Truck





Kreyenschmidt 2007

Average temperature:

front	7.24 +/- 5.14°C
middle	5.03 +/- 5.12°C
back	2.34 +/- 4.92°C

Average temperature:

environment	5,2°C* +/- 2,6
Surface	3,7°C +/- 0,4
Core	3,5°C +/- 0,3

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General problems regarding cold chain-management in meat supply chains

- Monitored temperature data are often not meaningful

- An effective data analysis with special regard to the temperature history of the product is often missing
  (calculation of the shelf life resp. remaining shelf life)

- The exchange of temperature data over the whole chain is missing (no integrated system)

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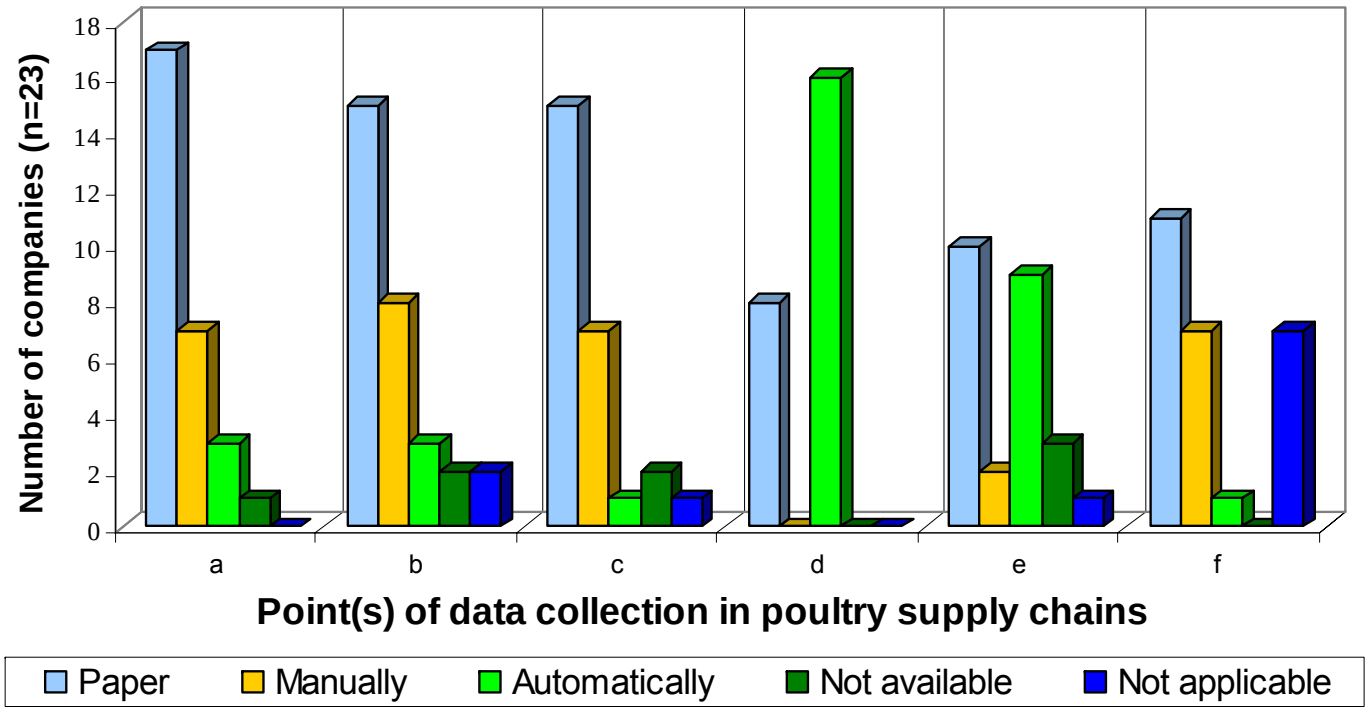
Results of an empirical supply chain analysis

Data collection and storage of quality and temperature date at different steps in German poultry supply chains



a: data collection at the incoming inspection
b: data collection during process
c: data collection at the goods issue
d: temperature data of the storage rooms
e: temperature data of transport vehicles
f: date/time and places of reception

Raab et al. 2008[1]

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General problems regarding cold chain-management in meat supply chains

- Monitored temperature data are often not meaningful
- An effective data analysis with special regard to the product is often missing
  (calculation of the shelf life resp. remaining shelf life)
- The exchange of temperature data over the whole chain is missing (no integrated system)
- Cold chain interruption often takes place after the point of sale
- For consumer interruption of the cold chain is mostly not detectable

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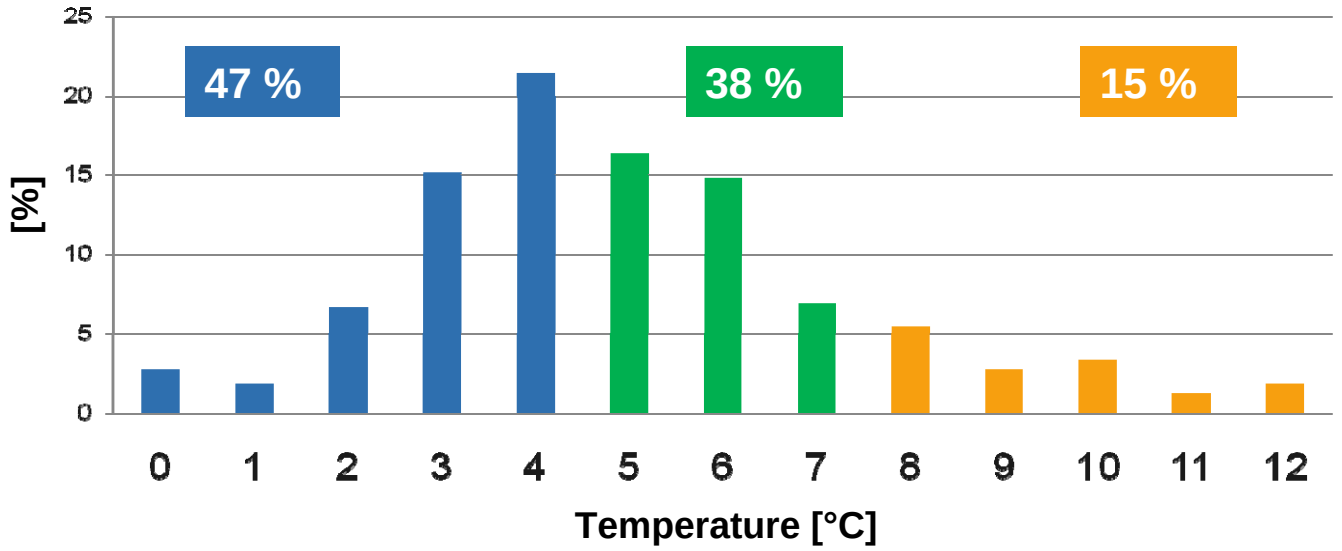
Temperature conditions in the food chain

Storage temperatures in private household refrigerators (recommendation: 5°C)



Reference: Simone Thomas, Erhebung des Verbraucherverhaltens bei der Lagerung verderblicher Lebensmittel in Europa, Shaker-Verlag 2007

Average T [°C]	Minimal T [°C]	Maximal T [°C]	Quantity	Country	% > °C	Reference
6,6	0,9	11,4	119	France	80% > 5°C	*Laguerre et. al, 2002*
7,9	2,2	10,1	13	Germany	-	*Bruckner, 2006*

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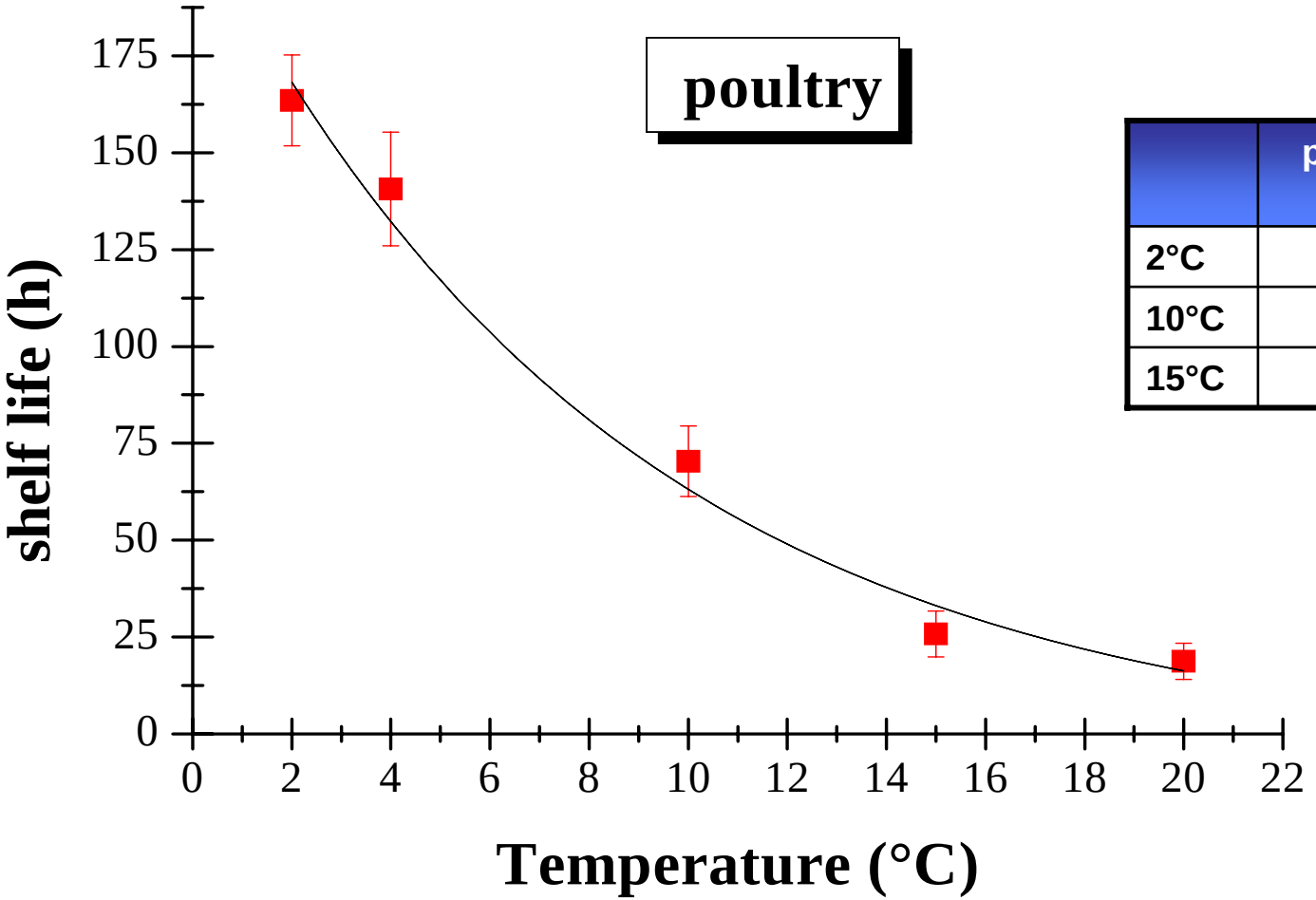
Shelf life of different food products



	poultry	Cooked ham
2°C	164	525
10°C	70	180
15°C	26	115

Kreyenschmidt, 2003

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Possibilities for temperature monitoring

- **Conventional thermometry**
- **Electronic datalogger**

- **Smart Wireless Autonomous Microsystems**

wireless data collection and data exchange
communication by Bluetooth, GSM, Infrared, RFID
components: microsensor, signal processing element, energy

- **Time-Temperature-Indicators**

Sensors which show the temperature history of products by colour change

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Time-Temperature-Indicators (TTI)
Monitoring temperature conditions from production to consumption

Principle:
Temperature dependent chemical, physical, microbiological and enzymatic reaction

Advantage:
continuous monitoring of product temperature,
Estimation of remaining product shelf life

Requirements:
easy handling, high reliability, low costs, independent of external influences, visualization of the reaction, high resistance towards mechanical load, not toxic

The most important requirement of TTI is an easy adaption to food spoilage processes!

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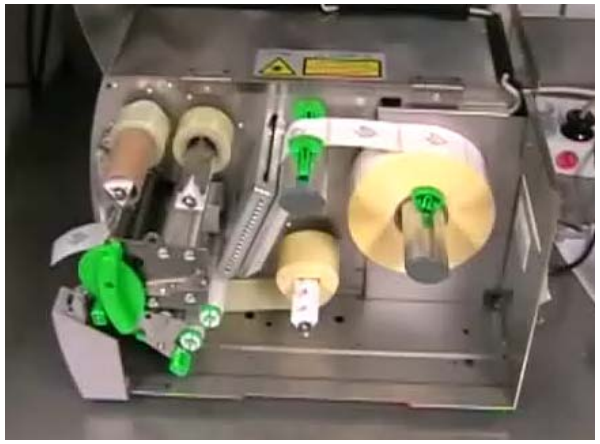
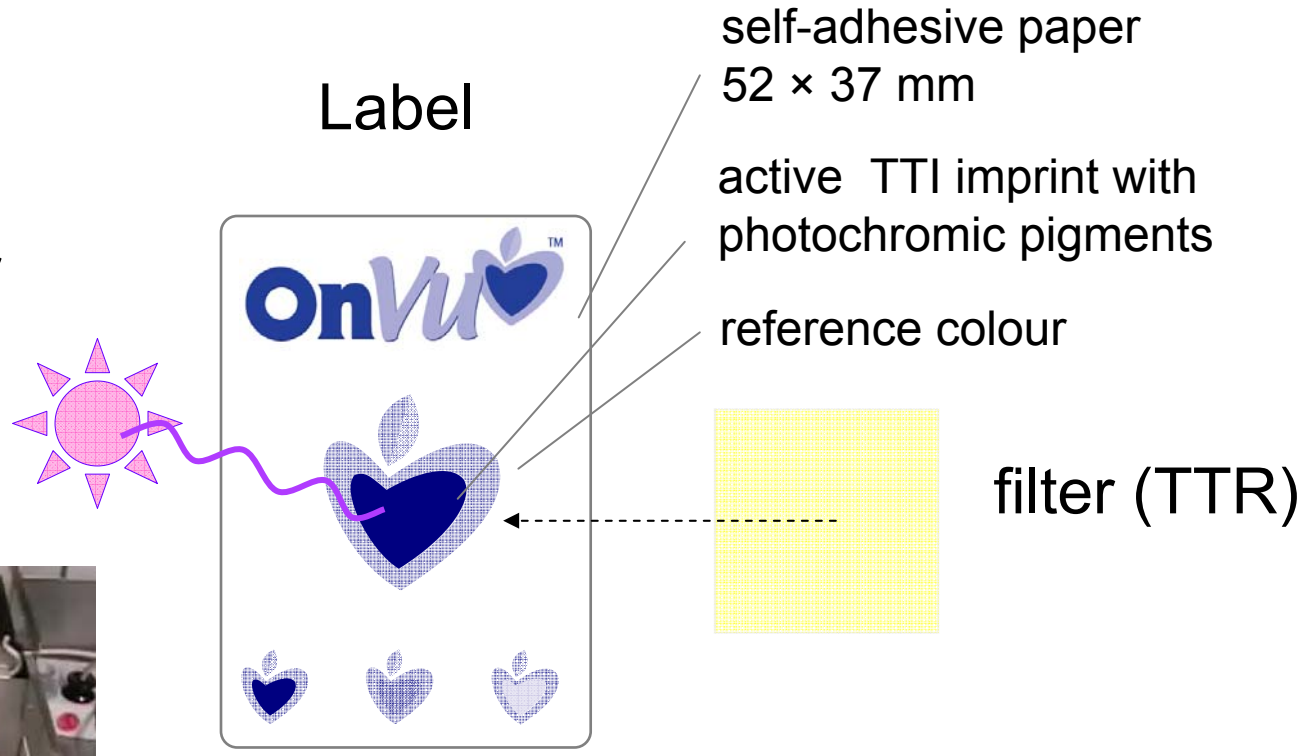
OnVu™ TTI Technology – Properties





TTR: thermotransfer band

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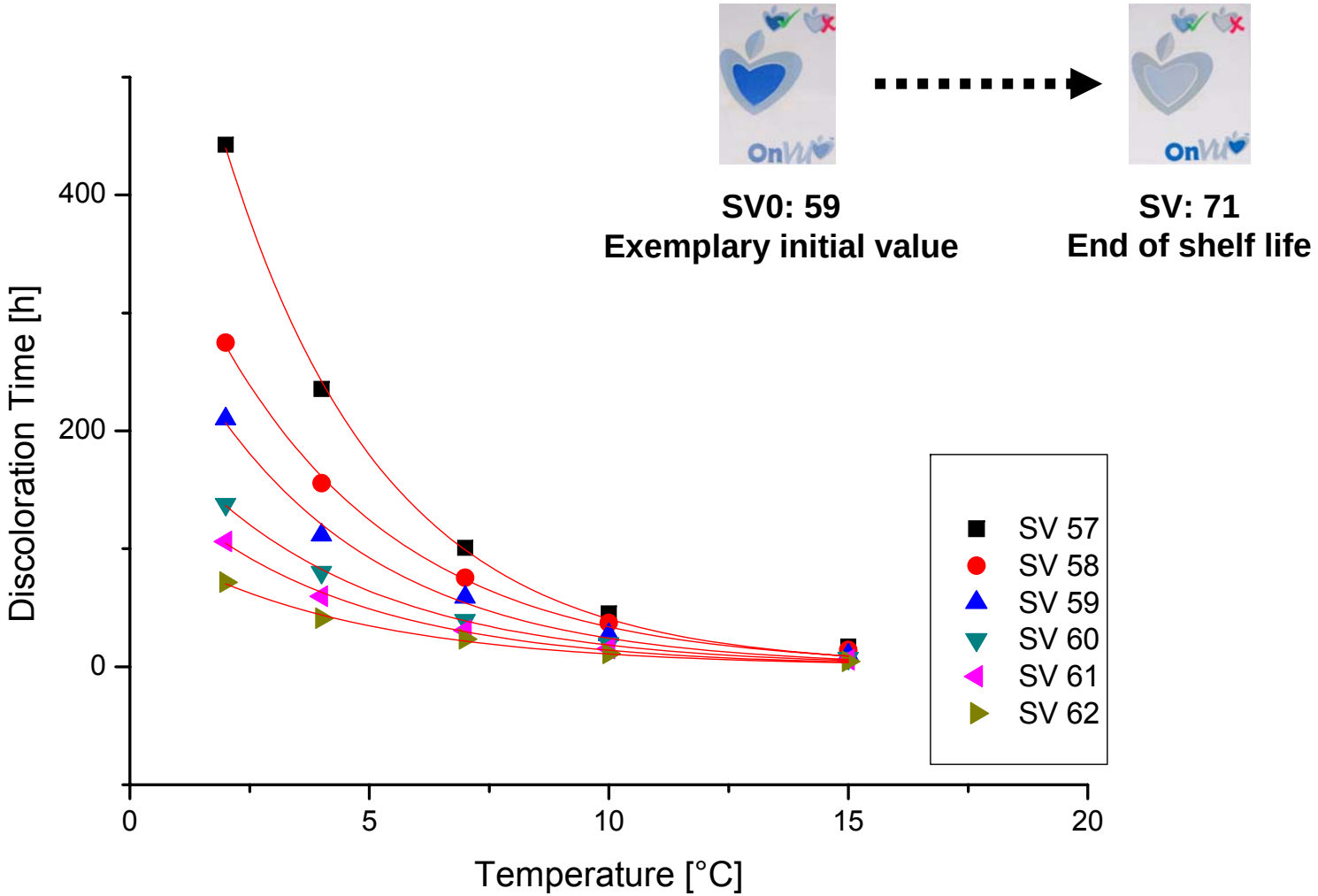
Discoloration of the OnVu-TTIs in dependency of temperature, time and activation



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Applicability of time-temperature indicators to monitor food freshness

prerequisite: detailed knowledge of the deterioration process of the food

Development of a shelf life model (food kinetic)

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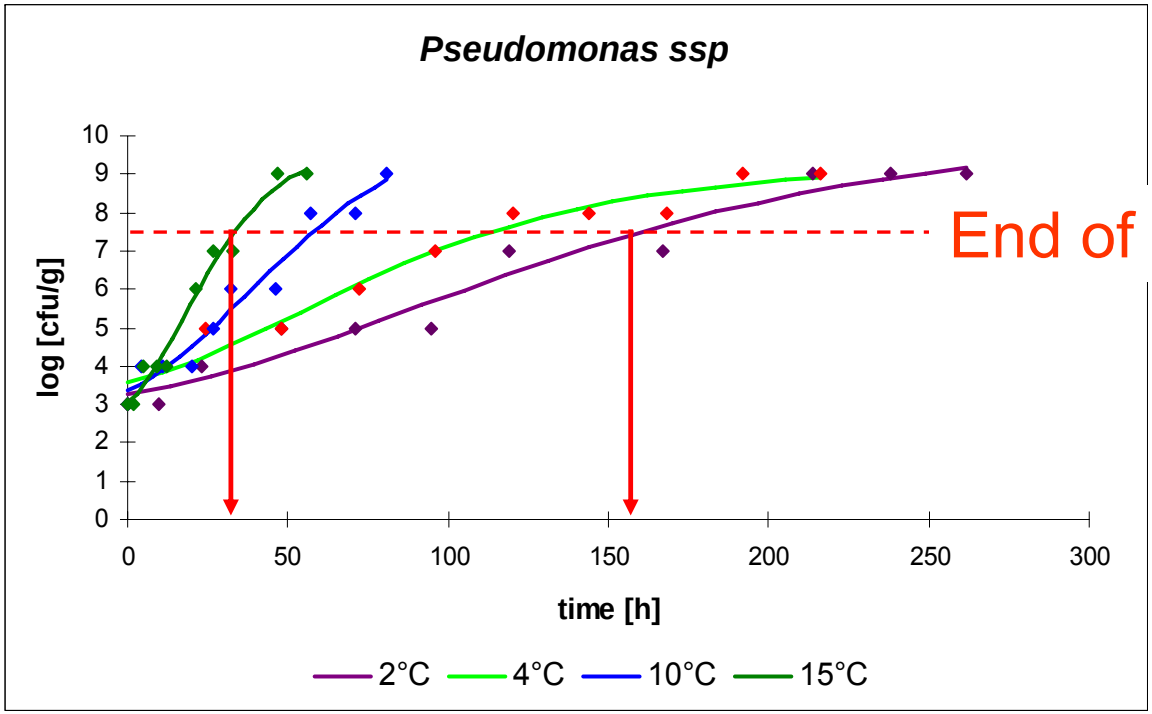
Shelf life modeling

Microbiological growth in poultry filet at different temperatures



$$\frac{-dQ(Y)}{dt} = k\left(E_i; X_j\right)$$

$$\ln(N/N_0) = k\mu \qquad \exp.[-E_A/R*T]*t$$

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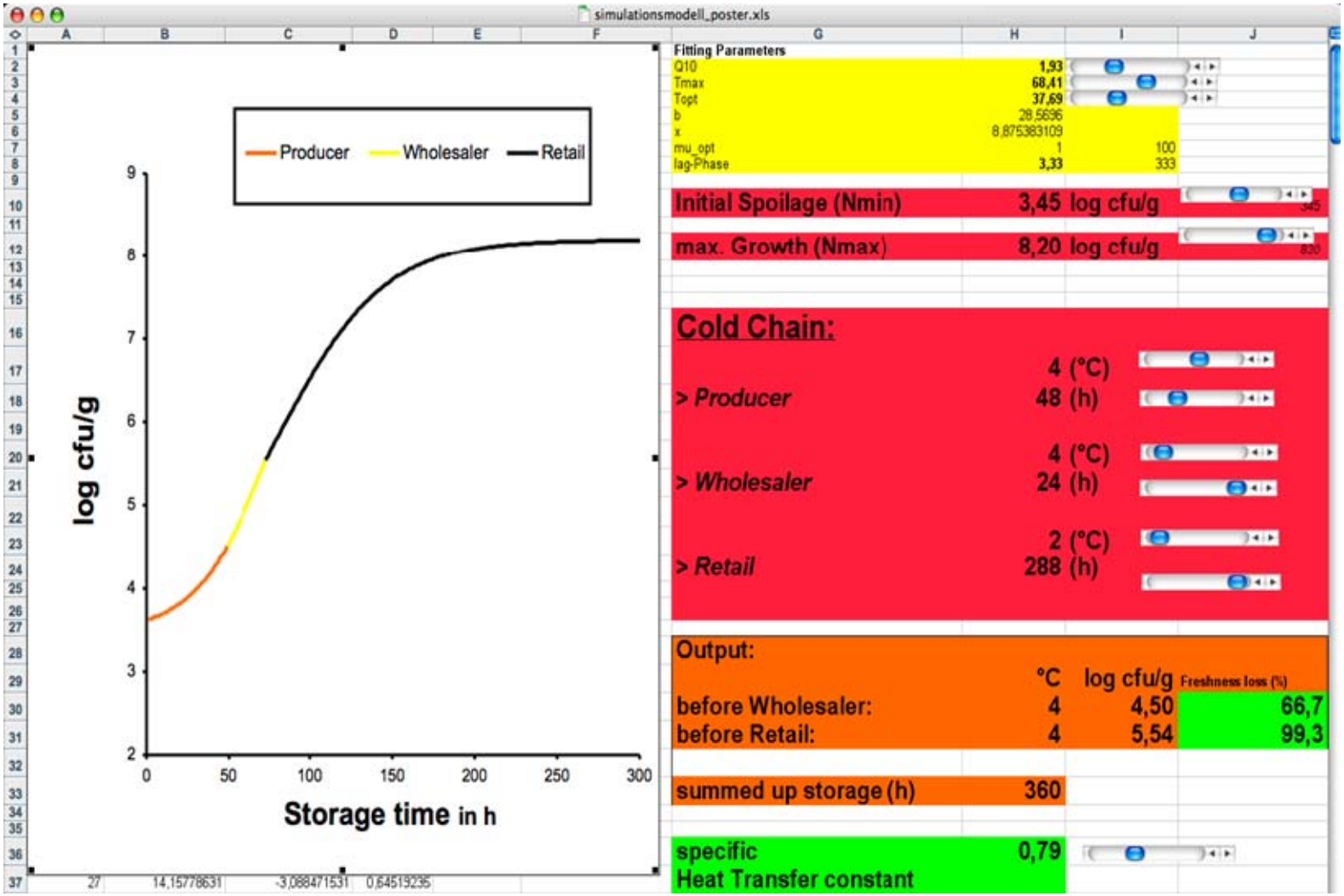
Shelf life modeling



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TTIs to control food freshness

Development of a shelf life model (food kinetic)

↓

Selection of the right time temperature indicator (TTI) system

↓

Combining the shelf life model with the TTI system

↓

Freshness control based on the temperature history of product

↓

Optimizing storage management and prevent waste

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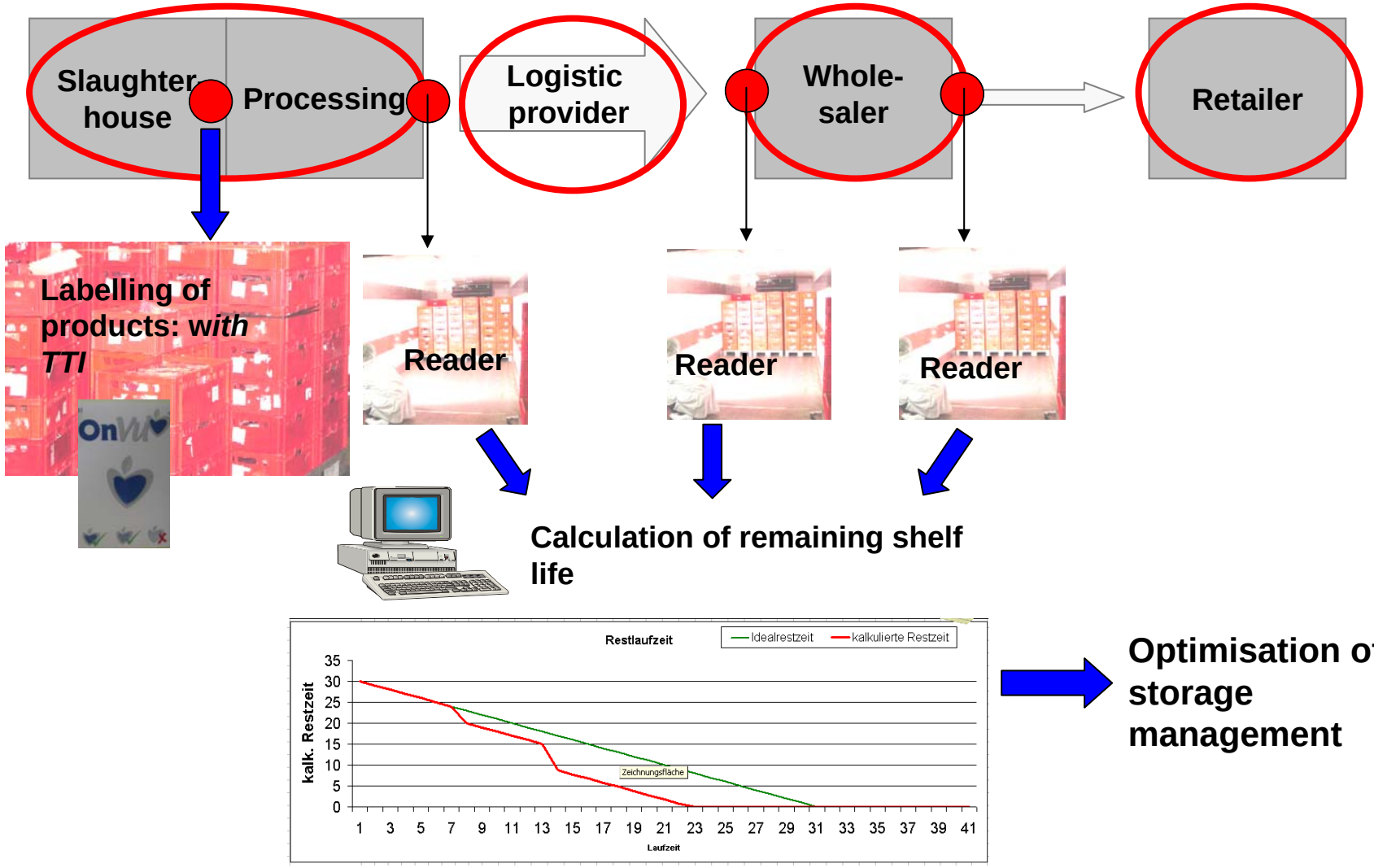
TTIs to control food freshness



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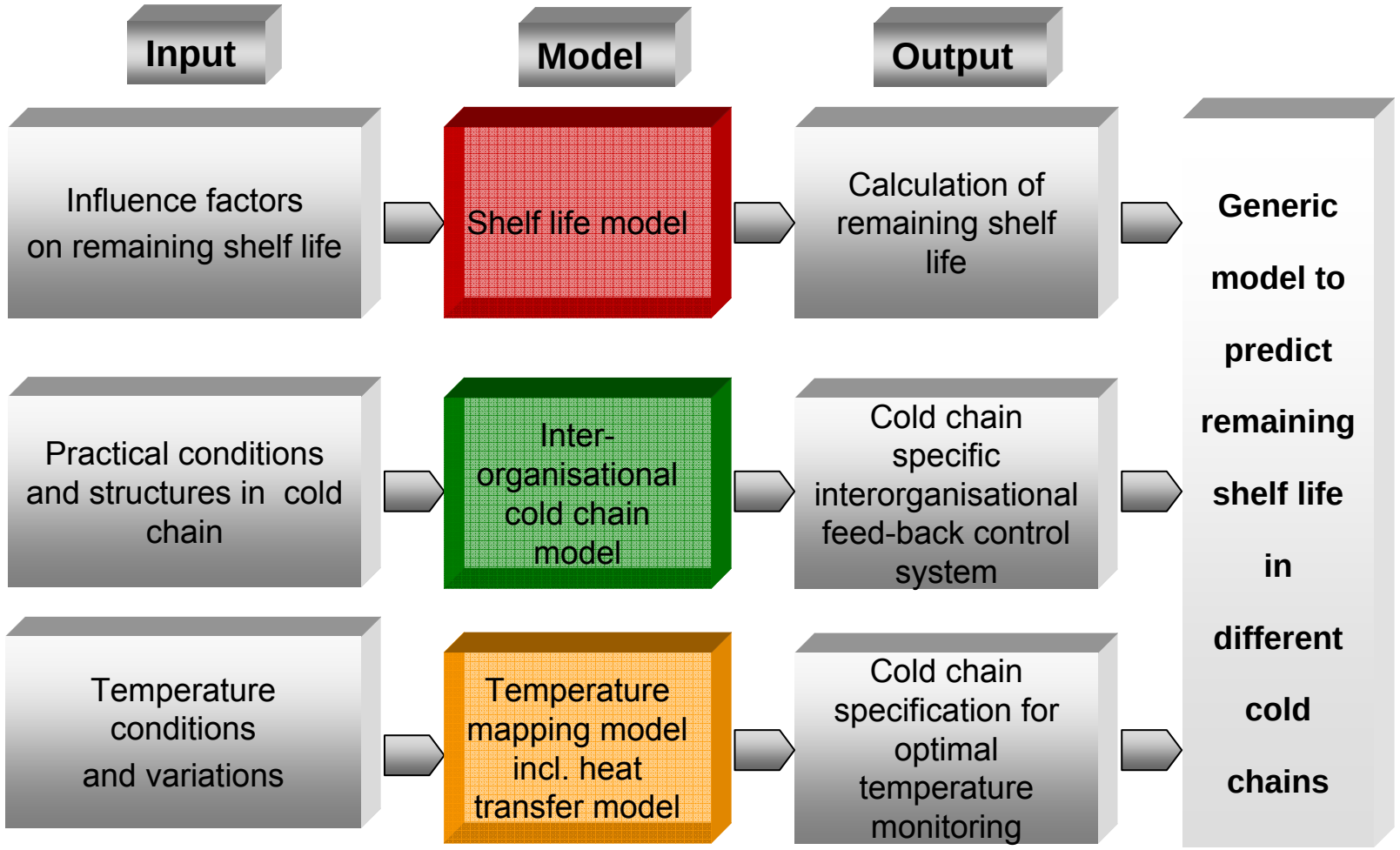
Factors keeping in mind by the integration of innovative tools



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Factors keeping in mind by the integration of innovative tools

- **Company specific requirements**
  Technical and organizational issues,
  software systems,
  financial aspects (cost benefits analysis),
  distribution ways and length,…

- **Chain specific requirements**
  Customer-Supplier-Relationships,
  market power of respective actors,
  step in the supply chain

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Thank you for your attention!

Contact:
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Working group Cold-chain-management
www.ccm.uni-bonn.de