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WEB2.0 based Software Solution to support a practical implementation of Time Temperature Indicators

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Outline of the presentation

- Motivation to develop a software to use TTIs in cold chains
- Short description of Time Temperature Indicators
- Development of a TTI kinetic model that also describes the spoilage of food and what is the basic algorithm for the software
- Field trial to validate the TTI kinetic model and the usability of Time Temperature Indicators within cold chains
- Presentation of an Internet based software to improve the cold chain management with the use of TTIs

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Face the facts of food chains

Motivation

- Continous increase of the consumption of chilled and frozen foods
  (BVE 2009, Deutsches Tiefkühlinstitut 2009)
- Our Industry faces 30% waste from harvest to the consumer while real food prices rose by 64% between 2002 and 2008
  (Helms 2010)
- Much remains to be done to eradicate the scandal of malnutrition in the context of the globalization of the world
  (Helms 2010)

➢ Also inefficient cold chain management leads to these facts!

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Face the facts of cold chains

Motivation

- There are huge temperature variations in transport vehicles which are often not detected
- Cold chain interruptions take often place at handover points which are mostly not monitored
- Monitored temperature data often differ from the products temperature, since the environmental temperature is measured
- Random measurement of the products temperature at the incoming inspection is not always sufficient
- The exchange of temperature data over the whole chain is missing, in general no integrated and sufficient systems are implemented

➢ Misinterpretation and lacks of information lead to inefficient management- and operational decisions in various steps of the cold chain

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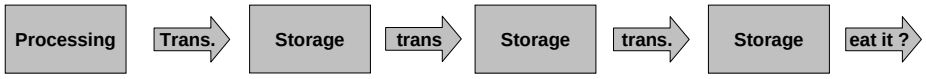
Challenges in the Supply Chain

Food Chain → Supply Chain → Cold Chain



Temperature monitoring devices

Plunge Thermometers

RFID data logger

Electronic data logger

Real-time monitoring via GPS

TTIs

Smart Active Labels

Challenges: data handling and -interpretation, information management
→ find cost effective decisions and decision-supports-tools

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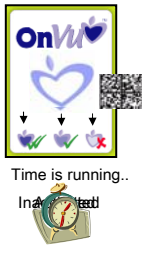
A Short Description of a Time Temperature Indicator

Principle of Time Temperature Indicators (TTIs): chemical, physical or enzymatic reactions provide information in dependency of Time and Temperature

Example:
Response in form of a discoloration (modern TTI) or melting (an ice-cube, glaciers)



- TTIs provide generally the option to continuously monitor the temperature history along the entire cold chain
  (Taoukis and Labuza 1989, Fu and Labuza 1992, Alfaro et al. 2009, Vaikousi et al. 2009)
- TTIs are able to provide indirectly an indication of the freshness of specific products

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Requirements to use TTIs for an effective decision-making

- Knowledge about the TTI-kinetic in dependency of Time and Temperature
- Possibility to adjust the TTI-kinetic to the spoilage of your products
- Cost-Efficiency
- Electronic readable and storable TTI-information
- Fast way to correlate the information of the TTI with product-information

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Aim of the study

The objective of this study was the development of an Internet based **software solution** integrating a **TTI kinetic model** as a **reliable and easy-to-use tool** to support the decision-making within cold supply chains.

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Steps to develop a Software

- Development of a TTI kinetic model to describe spoilage of food
- Validation of the TTI kinetic model within Field Trials
- Development of the Software
- Evaluation of the Software with gathered data from field trials

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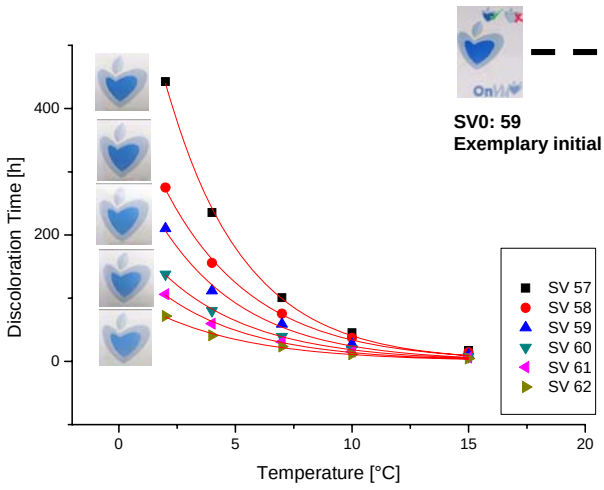
Development of a TTI kinetic model



SV0: 59
Exemplary initial value

SV: 71
End of shelf life

Kreyenschmidt et al. 2010

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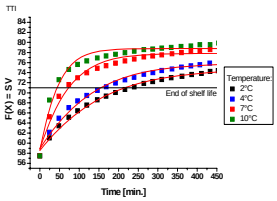
TTI-kinetic model

Development of a TTI kinetic model

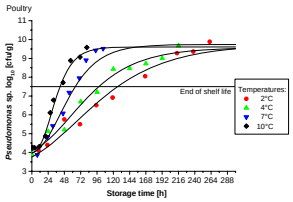
Laboratory model

Several studies have been conducted during the last years under isothermal and non-isothermal temperature conditions

TTIs



Growth of *Pseudomonas* sp.



Kinetic behaviour

Description of the kinetic behavior by different functions

Development of a TTI kinetic model: Kreyenschmidt et al. (2010) and Raab et al. (not published yet)

Validation

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Validation of the TTI kinetic model

Field trial to validate the TTI kinetic model

Slaughtering	Processing				Wholesaler	Butcheries	Storage until end of shelf life
	Packaging	Cold store	Consigne-ment sale	Docking station			

Ts

1 h	2 h	3 h	10 h	4 h	2 h	2 h	0,5 h	168 h
1	2	3		5		6		7-14
1	2	3	4	5		6		7 - 14
1						6		7-14

Integration & measuring points:

- OnVu TTIs
- Temperature logger
- Microbiological sample

- Step in the chain
- Information flow
- Product flow
- Ts Transport step
- x h Sojourn time

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Internet-based software solution

Features of the software-solution:

- The software allows user-friendly simulations of shelf-lives for dedicated products depending on dynamical and adjustable time-temperature-rows
- It is possible to simulate time and temperature scenarios for real or assumed supply chains
- When the software is used with TTIs, it allows to monitor the cold chain, to estimate remaining shelf life and so e.g. a storage optimization or to rate prices
- Software can be adjusted to different products, to different supply-chains and gives automated action alternatives
- Since the software is programmed with the widely known scripting language php and a mysql-database it is compatible with most servers of commercial internet providers and it can be easily updated and administrated

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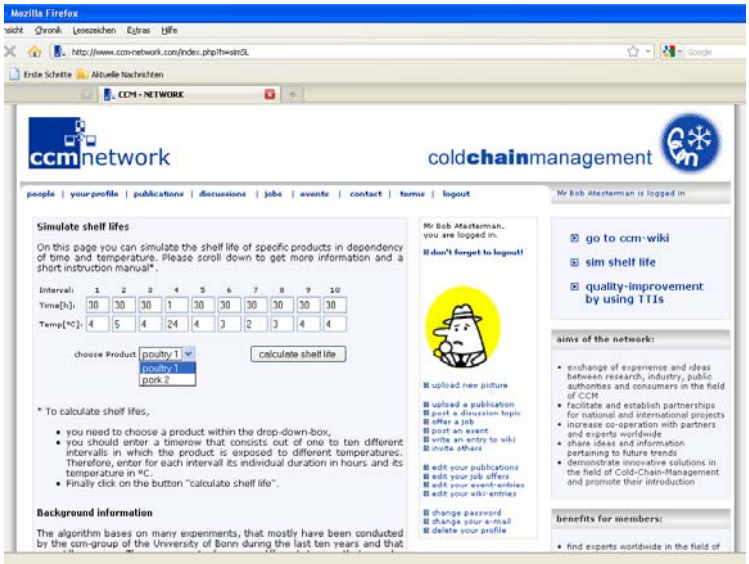
How to use? – Simulate Shelf Life

Presentation of the Software



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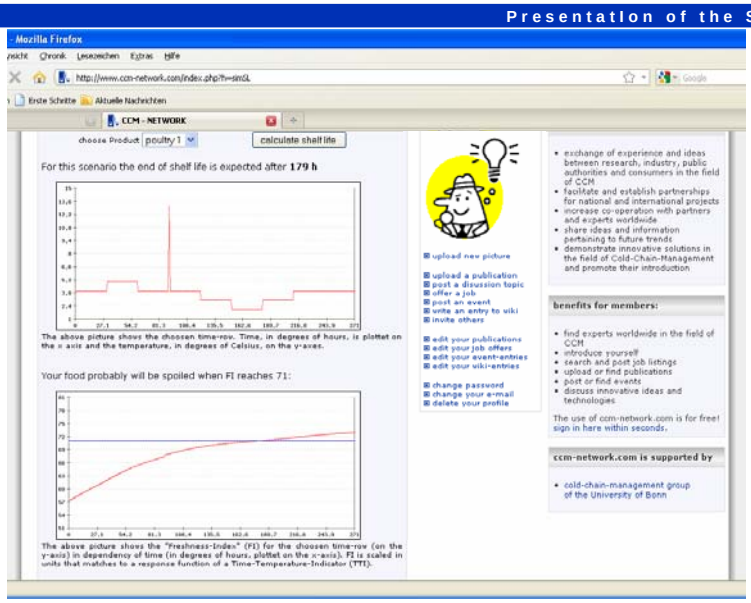
Simulate Shelf Life - Result

Presentation of the Software



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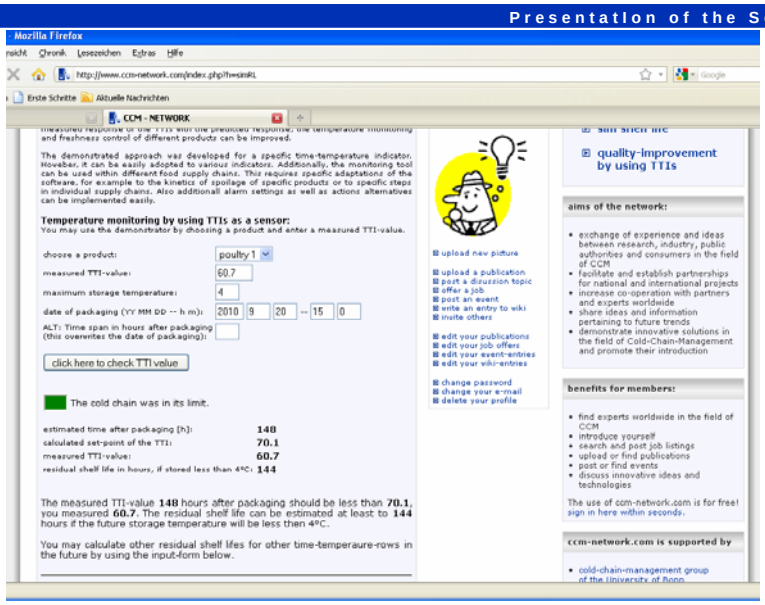
Check a very good cold chain ;-)

Presentation of the Software



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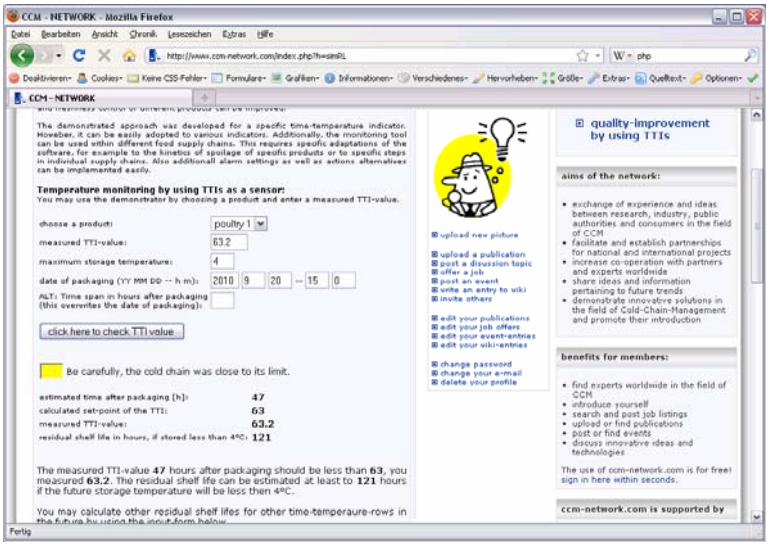
Check a good cold chain ; - |

Presentation of the Software



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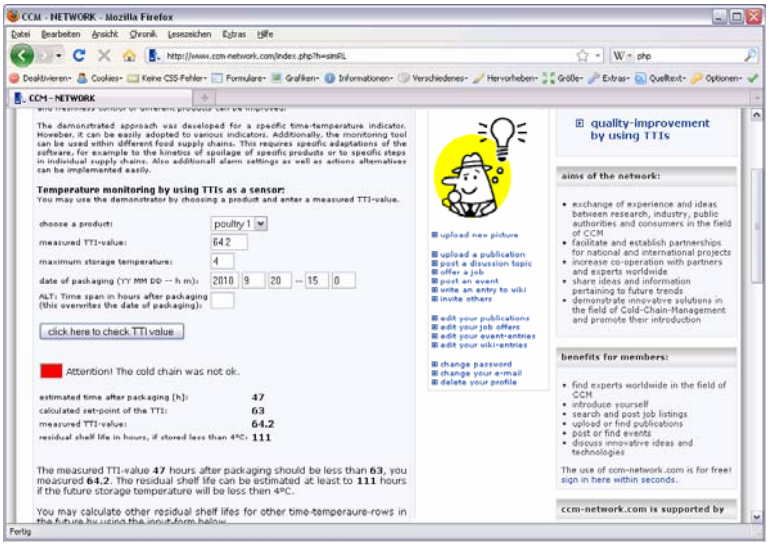
Just Check a cold chain ; - (

Presentation of the Software



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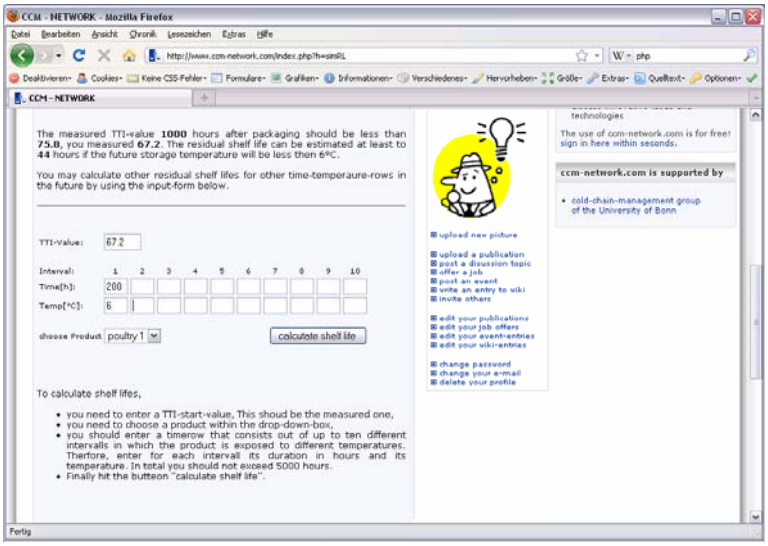
Estimate remaining shelf life

Presentation of the Software



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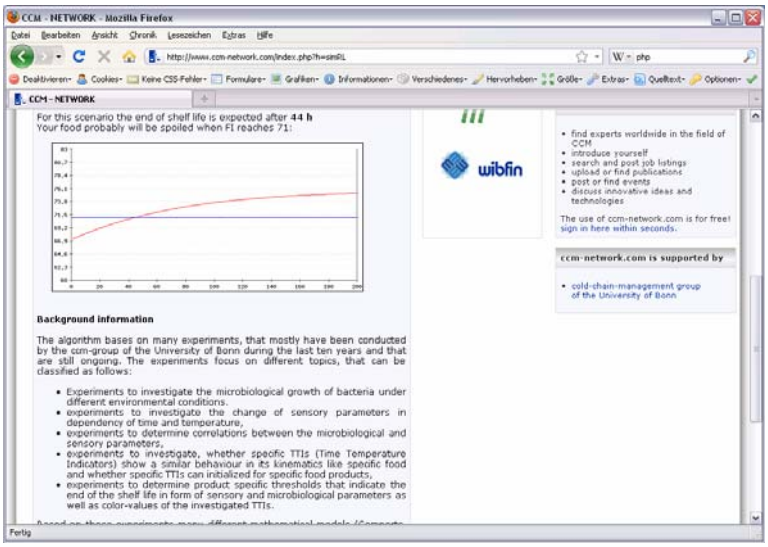
How to use? Remaining shelf life

Presentation of the Software



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Conclusions

Application in real cold supply chains

- The field tests showed the applicability and usefulness of the internet based software solution
- Allows an economical integration of the TTIs into temperature monitoring systems
- Enhances the possible spectrum of applications by using TTIs together combined with software
- Flexible integration according to the structure of international food chains

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Thank you for your attention!

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