TagItSmart
Smart tags driven service platform for enabling ecosystems of connected objects

Grant agreement 688061

Final Report on Performed Activities

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Document history

Revision	Date	Modification	Authors
V0.1	29.12.2017	Initial draft	Matthias Brunner
V1.0	09.01.2018	First submitted version	Matthias Brunner
V1.1	23.01.2018	Changes required by N. Gligoric implemented	Rahul Tomar
V2.0	03.08.2018	Re-work after rejection	Matthias Brunner
V2.1	06.08.2018	Feedback implemented	Matthias Brunner

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List of Attachements

Attachement 1: Logging of working hours, file: Stunden-vom-2017-09-01-bis-2017-11-30.pdf
Attachement 2: Details on travaling cost file: 2017-12-29_travel-expenses-TagItSmart

Section 1 - Summary of the work performed

The work performed during the project followed the detailed description of the work as defined in the FreshTag proposal. The development of the FreshTag project is split into three work packages:

- WP1 Requirement analysis, architectural design and implementation
- WP2 Algorithms for Food Modelling and Fresh Index calculation
- WP3 Concept validation and dissemination

The work targets to find the optimum process to predict the dynamic shelf life providing stringent uncertainty handling and minimal operating costs.

In WP1, a profound requirement analysis has been made to assure a good product to market fit. Based on the analysis results the architecture of the final solution has been designed. The core elements of the architecture as well as the corresponding web and mobile user interfaces have been implemented. WP1 was successfully finished according to the project time plan. The detailed results are covered by Deliverable 1: Definition of IT architecture and Implementation, submitted on 29.12.2017.

In WP2 the mathematical models for the calculation of cell growth at constant temperature has been engineered and implemented in the FreshTag cloud solution . The work shows very good accordance between calculation and lab testing results. After the lab testing, the module was released for the real-life testing in Serbia

In WP3, the field testing of the module was done in collaboration with the project partner DUNAVNet and the food retailer UniverExport. Due to late arrival of other TagItSmart sensors, the trail had to be postponed twice. The TagItSmart systems of DunavNET and tsenso were connected and worked reliably during all the live testing. At the end of the live testing 6 meat samples were flown to Germany to be analysed in a certified food laboratory. The results of the FreshTag module were well confirmed by the the laboratory cross-check.

As foreseen, the budget of the FreshTag project exceeded the maximum fundable amount by the TagItSmart project. tsenso regards the uncovered budget of the project as an investment to future market success. The FreshTag project was acknowledged as a big success by the managing partner of tsenso as well as the trial partner UniverExport. We hope to continue the successful collaboration with the TagItSmart companies even after the end of the project by future joint grant applications. The development of the FreshIndex approach to food safety will continue past the end of the TagItSmart project as recently an follow-on funding project by the German Ministry of Research and Education was successfully acquired.

Section 2 - Detailed description

2.1 Concept, Objectives, Set-up and Background

The FreshTag Concept
FreshTag is a cloud based food monitoring SaaS solution to tell the precise freshness and quality of food along the supply chain.

Todays food safety procedures, such as the expiry date, are causing significant food waste and contain no information on the true freshness of food, as the storage conditions after production are not openly available. The FreshTag module, links the storage monitoring data of the individual players in the food supply chain, such as producers, logistics, storage, retail and delivery services and the TagItSmart logistics monitoring loggers .

Great care has been paid to data protection and to identify any manipulation, such as tempering with sensors. The result is, the individual temperature history for each single product, which is treated highly confidential. Based on the complete temperature history and the characteristics of the individual product, we calculate the decay of the product using food modeling. This is used to check whether the safety has actually been influenced by temperature fluctuations and whether the food is still suitable for sale and consumption, and how long the true remaining shelf-life is. For this complex analysis we have initiated cooperation with the University of Wageningen, leading in the field of food research.

The complex data from the simulation is combined and translated in a simple number: the fresh index. This index is intuitively understandable also to a non-expert in the food sector and shows at a glance how fresh and safe a product is, and in openly accessible. The overall aim of the FreshTag proposal was to provide an external module for the TagItSmart solution platform that provides a tool for a dynamic shelf-life prediction and to validate its functionality by a two-week field trial, monitoring meat transports.

Objective 1: Understand the industry requirements and define an appropriate IT architecture
In order for the FreshTag simulation module to yield optimal results, the design of the IT architecture needs to directly connect to the TagItSmart Ecosystem and comply with the internal and external requirements. The development, therefore, started off with an extensive requirement analysis.

Using the APIs provided by the TagItSmart ecosystem, most of all by DunavNET, a data processing concept was designed to allow the already existing tsenso monitoring system able to query and publish the product and shelf-life related data to the TagItSmart System and have this information be displayed as part of the TagitSmart mobile app. The result of this analysis was described in Deliverable 1.

Objective 2: Develop and validate a use-case specifit shelf-life prediction model

Whereas WP1 established the structure and raw data exchange of the FreshTag module, WP2 fills it with meaningful functionality. The shelf-life prediction algorithms are based on

existing scientific work done by our Co-Founder Prof. Christian Fleck at Wageningen University.

A supporting database was implemented as a reference cross-check for the plausibility of incoming data and as a a reference for missing data, such as hygienic information of the food production process, that are currently not available in the system due to the early stage of the roll-out. The modeling calculations were compared to laboratory measurements to confirm the suitability of the presented food modeling approach for real-life supply chain validation.

The results showed a good correlation between the counts of *Pseudomonas* sp. and the sensory characteristics under constant as well as dynamic temperature conditions. It was possible to determine a common spoilage level at 7.5 $\log_{10}$ cfu/g for both meat types which defines the end of shelf life based on the growth of *Pseudomonas* sp. The temperature was identified as the most important influencing factor on the growth of *Pseudomonas* sp. and thus on the shelf life of both meat types.

Objective 3: Validate the accuracy of the models and the suitability of the handling processes in a real-life field test

The concept of field trials is a certain stage in the product development when the product under development is tested by users under 'real life' conditions. Based on the positive results of our food modeling, see Deliverable_D2, the FreshTag module has reached the maturity for this stage. The product and the field trial setting are designed to be as close as possible to actual usage. The aim of the trail is on the one side to prove its reliable functionality under real conditions. On the other side, we conducted interviews with users in order to plot the customer experiences in using our product. The trial happened in the city of Novi Sad, Serbia at one of the departmental stores of Univerexport.

In WP3 the developed solution was tested in the lab and potentially in a real field validation trial. From the manufacturers, the selected meat transports were registered in the FreshTag module and equipped with additional tsenso temperature sensors. When the transports arrived at their destination, the FrehIndex was calculated and displayed in the TagItSmart app. The accuracy of the FreshIndex calculation was successfully proven by a second set of lab tests performed by an independent food safety lab.

2.2 Technical results

2.2.1 Information handling and processing

This section provides an overall description of the FreshTag architecture and how it interconnects with the additional components that are introduced by the TagItSmart platform.

On the basis of the requirement analysis performed the following target KPIs were identified:

- Scalability:
  In the final product development stage, the solution needs to be able to manage the large data volumes generated by the food industry. The full tracking of all perishable food items for the German market corresponds to item volume of around 50 billion units per year. On the assumption of the size of a typical data set per unit in the order of 10 kByte, this leads to a scaling requirement for the database infrastructure to be able to handle 0.5 Petabyte per year.
- Confidentiality and Security:
  During our first discussions with METRO Food specialist company, we have seen a positive engagement and a willingness the make food safety data accessible for external value-adding solutions, such as the FreshTag module.
  On the other side, speaking to food producing enterprises, we have not encountered a similar trend. Even though measurements of production hygiene are required by EU law, the companies did not show any willingness to share these measurement data with the project. As a positive exception, we have mention Tönnies Lebensmittel GmbH & Co. KG in Rheda-Wiedenbrück, one of Germany's largest meat producer that has shown interest in our activities and plans to intensify the collaboration in 2018. Based on this complicated distribution of interest, we see a clear demand for a high level of confidentiality plus a multi-layer rights management that allows the precise definition on which data is shared with whom along the supply chain. Given the early stage of the product development, this demand will not be included in the development requirements but is documented in the product backlog for future customer projects.
- Commercial benefits:
  Given the early stage of the development a clear pricing strategy has not been defined or validated. As commercial requirements, we currently rely only on statements by Nikolas Bessas, Head of Supply Chain Management Germany and Sarah Blanchard, Head of Global Quality Innovation at METRO AG.
  - Target of product pricing: 3% of cargo value
    Given the average prices for pork meat: € 340,- per shipment pallet and veal: € 1800,- per shipment pallet this results in a pricing range for your solution between € 10,- to € 50,- .
  - Cost to value ration: 1 : 20
    The value created by our solution, such as cost saving, fraud protection or increased revenues due to dynamic pricing must be more than 20 times the cost of the solution. The maximum amortisation period is not to exceed 24 months.

On the basis of the requirement analysis performed the following IT architecture has been defined.

The frontend related tasks are managed by a designated Data Module. The incoming sensor, product and logistics data is received by a context broker module inside the Data Module. It also responsible for updating future web and mobile applications, such as a business intelligence toolbox and the internal applications for quality assurance using data science.

The Data Module performs the initial data quality checks and links the respective sensor and logistic data to the corresponding product unit. The in-depth analysis of the food freshness will be performed by the Simulation Module.

The data pipeline is defined by:

a) Data ingestion, managed by the Data Module with a focus on high input/output availability.
b) Data curation, managed by the DM with a focus on data clustering for the reduction of persistent storage input and fingerprinting to identify fraudulent data
c) Data provisioning, in the concept of a data market, managed by the Data Module to assure high availability and also fast reactivity on customer requests via the web and mobile applications

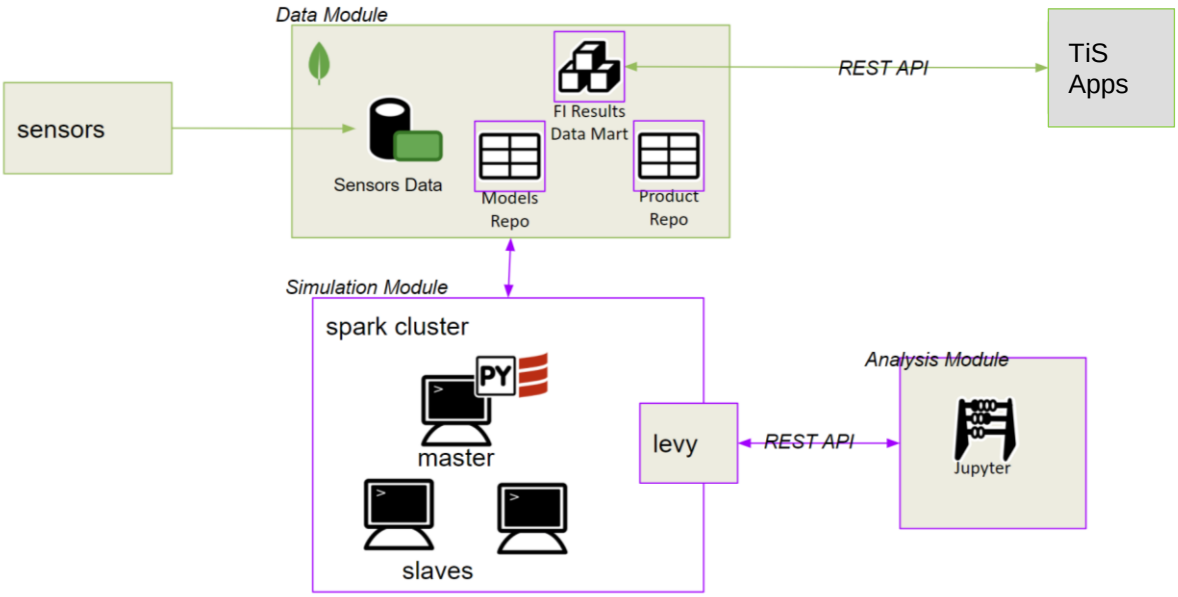

Figure 1: Implemented system architecture during FreshTag project and its connection to the TagItSmart System

2.2.2 Microbiological simulations

For one of the leading spoilage bacteria: *Pseudomonas* sp. a growth model on fresh pork and poultry at constant storage temperatures from 2 – 15°C was developed by fitting microbiological measurement data. The measurement results and the corresponding model fit can be seen in Figure 2 below. At the end of storage, the maximum number of *Pseudomonas* sp. did not show relevant differences between both meat types (about 9 – 10 $\log_{10}$ cfu/g), independent of temperature and initial bacterial count. Increasing temperature

led to a faster growth with fresh pork and poultry A comparison of growth in fresh pork and poultry revealed that growth was faster on poultry than on pork.

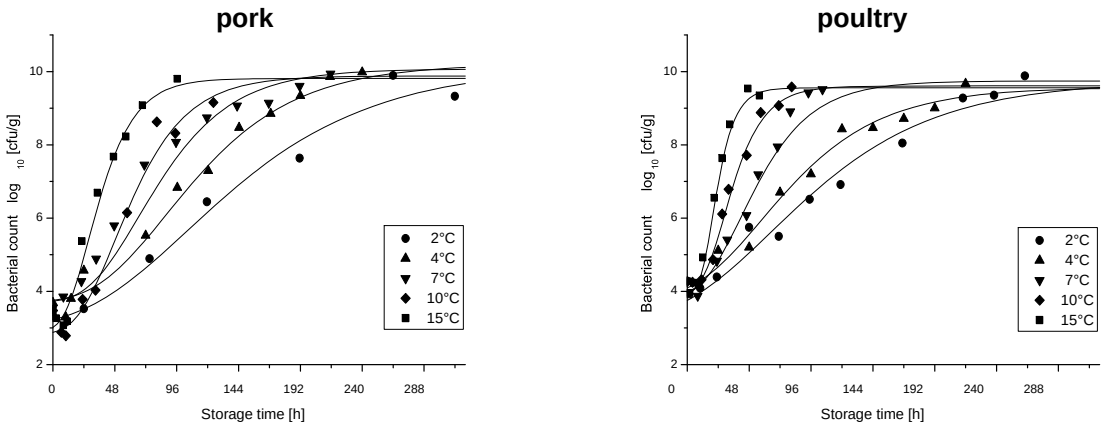

Figure 2: Growth of Pseudomonas *sp. on fresh pork (left) and poultry (right) at constant storage temperatures fitted with the Gompertz model*

At each constant storage temperature level, the shelf life of fresh pork was longer than the shelf life of fresh poultry. The decay of shelf life with increasing temperature can be described exponentially (Figure 2.3). Differences between the shelf life of fresh pork and fresh poultry were between 18.4 h and 39.4 h for microbial shelf life and 16.6 h and 54.4 h for sensory shelf life, respectively.

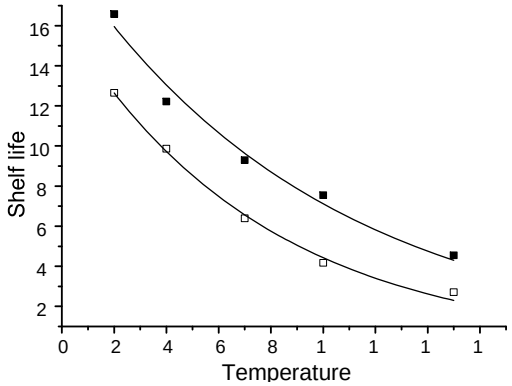

Figure 3: Microbial shelf life of fresh pork (■) and poultry (□) at different constant storage temperatures

The Fresh index (FI) decreased linearly for fresh pork and poultry. With increasing storage temperature, a faster decrease of the FI was observed.

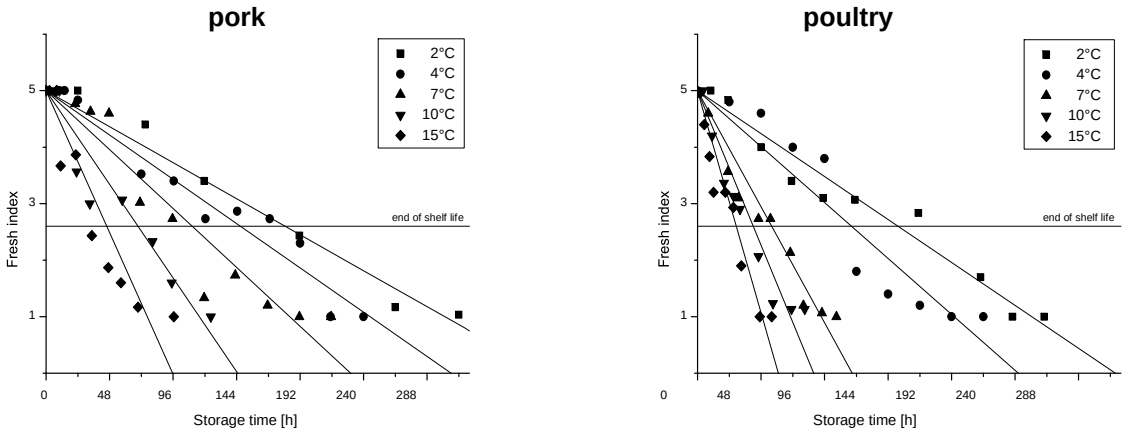

Figure 4: Fresh index for fresh pork (left) and poultry (right) at different constant storage temperatures (Consumers rated a product as "reduced freshness", when FreshIndex was lower FI ≤ 2.7)

The results showed a good correlation between the counts of *Pseudomonas* sp. and the sensory characteristics under constant as well as dynamic temperature conditions. It was possible to determine a common spoilage level at 7.5 $\log_{10}$ cfu/g for both meat types which defines the end of shelf life based on the growth of *Pseudomonas* sp. The temperature was identified as the most important influencing factor on the growth of *Pseudomonas* sp. and thus on the shelf life of both meat types. Also, the decay of the Fresh Index fits moderately well with the basic, intuitive expectations. The results confirm the suitability of the presented food modeling approach for real-life supply chain validation.

2.2.3 Field validation

The reliable functionality of the FreshTag module depends on reliable temperature sensor data loggers that can be attached to the meat package during transport. The loggers collect the temperature on regular intervals without any break. The FreshTag module can operate with temperature data loggers of any other manufacturer. For the trail, we used our own tsenso Bluetooth Low Energy (BLE) loggers, as they offer a very good price-value ratio.

During the trial, one sensor was attached to a single product unit. In the case of an industrial roll-out of the solution, one data logger will be used to monitor a full pallet of products or a refrigeration unit. This difference of set-up in the trial is due to the fact that the trial was done in parallel with the second TagItSmart dynamic pricing trial, for with also one third party module was attached to one product as well.

At Univerexport departmental store, Novi Sad, a special TagItSmart counter has been set up with meat products provided by the manufacturer Bačka AD from Serbia. Meat packages arrived at the departmental store on 05th May 2018 at 09:00.

First, the store personnel manually managed the inventory and in parallel attached the Univerexport TagItSmart Tag on the products. A representative category manager and a sales representative from Univerexport organization were present all the time for the trial. They supervised the trail and provided information about the TagItSmart project to all

consumers visiting the counter and to show them how the mobile application of TagItSmart works with the QR code.

At 09:45 meat packages arrived at the cooling shelf via the store personnel and were arranged for customer display. During the arrangement, a representative from tsenso GmbH has attached the temperature data loggers with FreshIndex QR code to the 6 randomly selected Pork packets.

Figure 10: Meat packets at Univerexport with TagItSmart tags attached

Once the app is on the smartphone, then by scanning the FreshTag label, register users can:

- Enter new product (Figure 5, left)
- Assign a new temperature monitoring to a product, e.g. when it is moved from the truck to the warehouse or the attached sensor is exchanged (Figure 5, middle)
- Query the temperature history and the current freshness level (Figure 5, right)

Just by attaching the temperature logger to each product with few simple steps Univerexport can get the right freshness of the packed Pork meat on the tip of their smartphone. Critical temperature limit can be set and during the monitoring period if any criticality comes immediately the Univerexport responsible person will receive a notification on email in real-time to act.

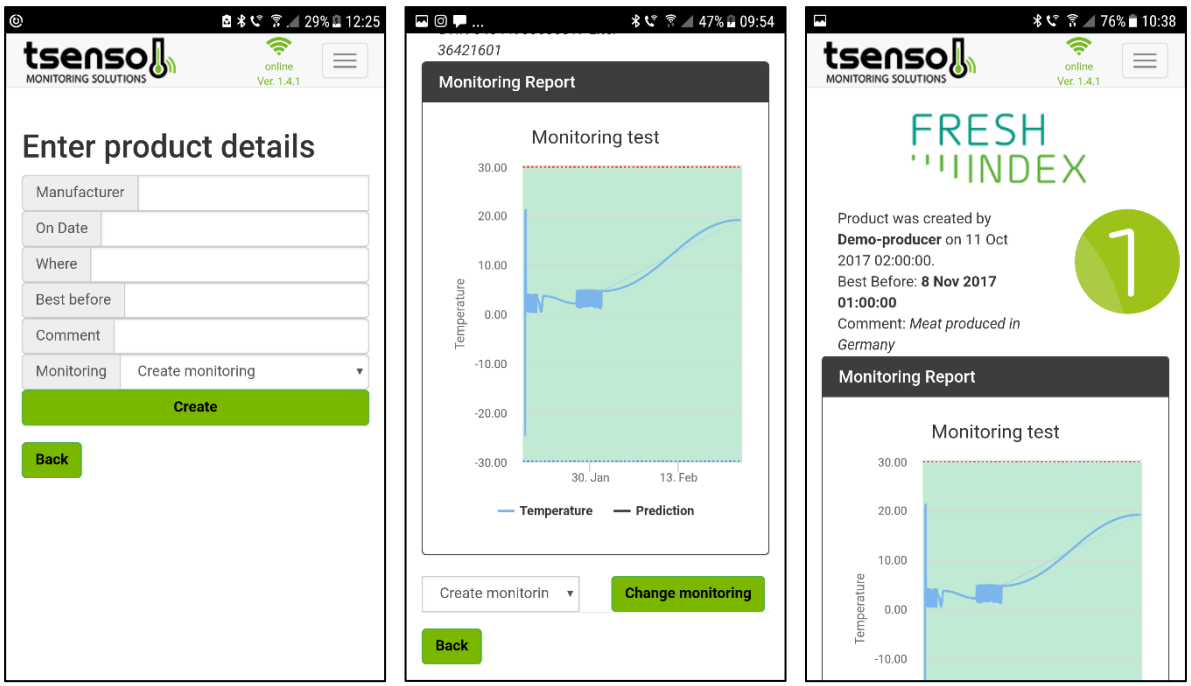

Figure 5: Detailed information on product data, accessible only to registered customers.

After following the above steps, the tsenso application directed the user to the FreshIndex screen. Initially, user will see the screen with GIF circle representing the calculation of FreshIndex through the simulator on the server side for about 0.5 to 0.8 seconds. At this point, the system is starting up and has only data entered by user available. As soon as the first temperature data arrives the FreshIndex is calculated. Definition of each number 1 – 5 for FreshIndex can be seen here, Figure 5, right.

With TagItSmart mobile application also consumers can have in just one click the freshness of the product. It will be very interesting to the consumer to know about the freshness of the product among other details of the product provided by the TagItSmart mobile application.

Today consumer is looking for the transparency of food ingredients and other provided by few market players globally. The main feature all these applications are lacking is to give info on the freshness of the food which is one of the most important health aspects. This crucial information is provided by tsenso integrated into the application of TagItSmart.

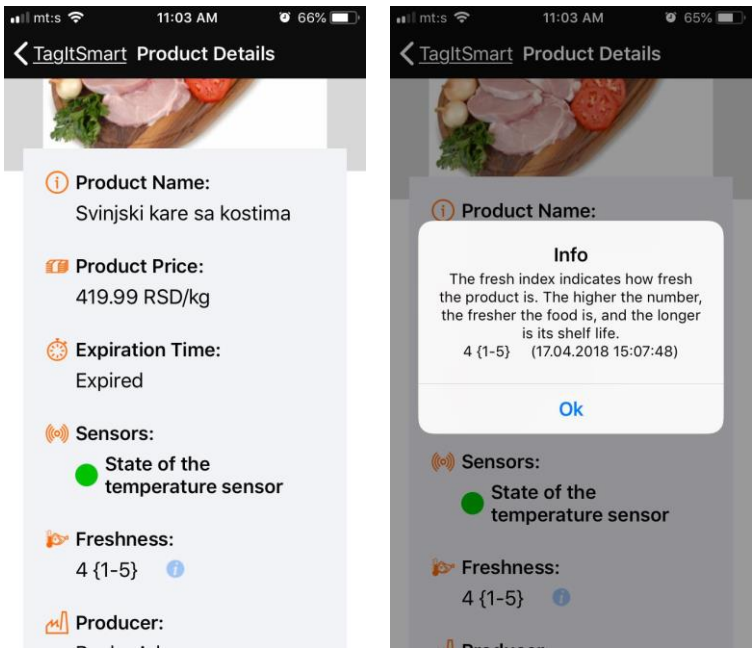

Figure 15: Picture of TagItSmart mobile application in action

In order to be able to compare the calculation results of the FreshTag module with the correct microbiological conditions, six meat products were taken from the TagItSmart shelf in the similar matter as a consumer would do and placed in a passively cool isothermal container at the point of sales. The products were transported by temperature-controlled air freight from Novi Sad, Serbia to Stuttgart, Germany.

In Stuttgart, the products were handed over to the iPDP INSTITUT PIELDNER, Julius-Hölder-Str. 20, D-70597 Stuttgart, an independent, DAkkS accredited food safety laboratory. At iPDP the three samples were tested on the 07.05.2018, while two samples were stored for one more week at +4.0 °C and analyzed at iPDP on the 14.05.2018. The storage test was advised in order to check the long-time comparison of the FreshTag results also for dates past the expiry date specified on the product.

The results of the iPDP tests are shown in Figure 6. One of the two products designated for the long-time storage showed a rupture of the modified atmosphere packaging. The time and cause of this rupture are not known precisely, but we assume that the damage occurred during the air transport. On the advice of iPDP the sample was not included in the testing, as the results are not comparable.

The laboratory results and the calculation of bacterial growth of the FreshTag simulation module are plotted in Figure 6 **Fehler! Verweisquelle konnte nicht gefunden werden.**and show good accordance. The simulation overestimated the microbial activity and predicts a slightly faster spoilage than observed in the lab test. This is mainly due to the fact that the precise composition of the modified protection atmosphere was unknown and a default atmosphere was assumed. To improve the precision of the calculation details of the production and packaging process can be included in the algorithms. This promising work could be done as part of a future joint grant proposal.

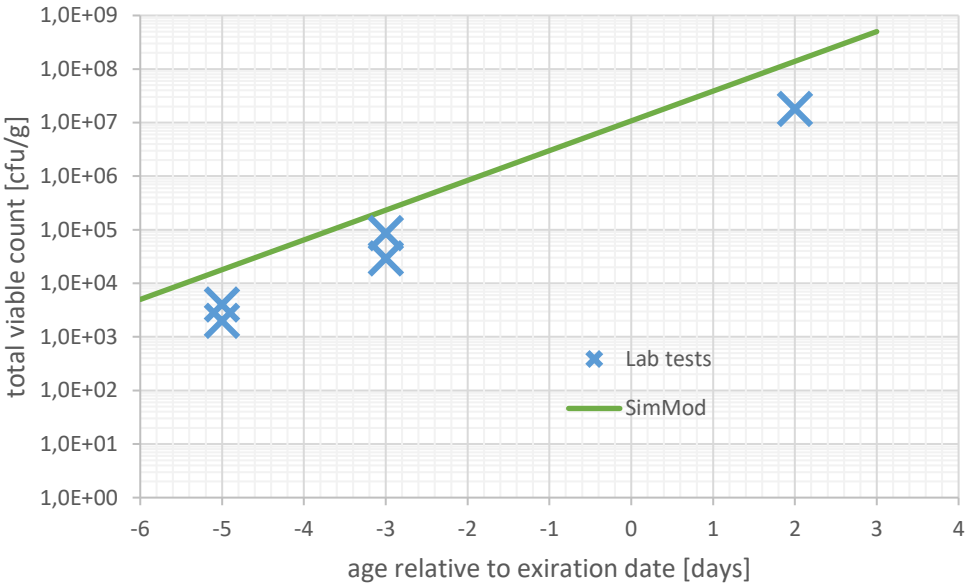

Figure 6: Comparison of calculation of the FreshTag simulation module and the lab test

2.3 Lessons learned

The FreshTag module has been developed successfully as part of the TagItSmart Open Call. The module offers the functionality of gapless temperature monitoring from the production of food to the presentation shelf inside the retail store. The solution offers food producers, logistics and food retailers the basic capabilities needed for professional use, such as user and permission management and an easy to understand dashboard. To reduce handling errors and cost connected with manual work, the sensors do not have any on/off functionality but the system if automatically managed by the cloud.

Described in deliverable FreshTag_D2 “Microbiological Shelf-life prediction” an algorithm for assessing the effect of the exposed storage temperature on the growth of microbiologic spoilage has been implemented and validated by laboratory measurements. The system was finally tested as part of the TagItSmart field test in collaboration with DunavNET and Univerexport. During the trial the FreshTag system functioned flawlessly. The temperature monitoring was extended from the point of sale at Univerexport, Novi Sad to include the transport of six samples via airfreight to Germany, where the samples were analyzed regarding their microbiological conditions. The lab results matched well with the prediction of the FreshTag module. The positive results may lay the foundation for future, extended projects for longer supply chains or to include different kinds of food products.

To increase the product market fit, we have performed a strategic management workshop together with food officials on October 19th 2017, 11:00 – 13:00h at Metrostr. 1, Düsseldorf

- Sarah Blanchard, Global Quality Innovation, METRO AG
- Britta Gallus, head of Global Quality, METRO AG
- Nikolaos Bessas, head of supply chain quality, METRO AG
- Charlotte Rosendahl, head of supply chain management, METRO C & C Germany
- Alina Vutcariov, supply chain management, METRO C & C Germany
- Peter Kaleck, head of logistics, METRO Logistics GmbH
- Oliver Teschl, IT responsible of METRO Quality system, METRO Systems GmbH

Figure 7: Results of product target requirements

Figure 8: Results of product risk brain-storming

For reasons of confidentiality the full results of the workshop cannot be included into this report.

2.4 Impact

2.4.1 Dissemination

The following activities have been performed to increase the impact of the project:

- 09.09.2017 participating at the iFood Conference, Cologne, Germany
  20 business cards of potentially interested food representatives secured. Hottest contact: Mr. Gouloudies from Aldi Süd technology department
- 27.09.2019 Linked Open Data conference organized by GODAN - Global Open Data for Agriculture and Nutrition and Germany Ministry for nutrition and agriculture
- 15.11.2017 presentation of the project idea as plenary speaker at the 31 Effost conference in Sidges, Spain. For details on the programm, please see:
  http://www.effostconference.com/resources/updateable/pdf/EFFO2017_Oral%20Programme%2001NOV17.pdf
  5 interesting contacts with European universities in the food production segment. One of the chairmen, Prof. Buckenhüskes is also the president of Gesellschaft Deutscher Lebensmitteltechnologen (GDL e.V., "German society of food technologists") and the organiser of the 2018 Anuga FoodTech. After the presentation, he offered us to be also presenting at the Anuga FoodTech in March 2018.
- 27.11.2017 FIWARE TechSumit, Malaga, exhibition booth, tsenso joined the SmartAgriGroup of FIWARE
- 12.12.2017 Pitch at the EVC finals for the "start-up of the year" award
  https://techtour.com/events/2017/12/event-evc-final.html
  Contact to 4 business angels and investors. Wiebke Langhans or the VR Equitypartner GmbH offered to introduce the FreshTag to the Westfeisch, one of the leading meat producers in Europe.
- 01.03.2018 Climate-KIC Berlin
  Presentation of the preliminary project results to a German CO2 reduction competition. The project was ranked in the TOP10 but failed to win a price reward
- 23.03.2018 ANUGA FoodTech, Köln
  Presentation of the preliminary project results to an international audience of food manufacturing, processing and quality assurance professionals. Good contacts to the Australian Meat and Livestock Association (MLA) and the Japanese Ashai Kasei Cooperation established.
- 24.04.2018, Participation at EU Startup Summit, Barcelona
- 29.04.2018 Meeting with the head of production and logistics of VION Convenience GmbH, one of Europe's leading producer of pork products
- 08.05.2018 FIWARE Global Sumit, Porto, networking with SmartAgriGroup and International Industrial Data Space association.
- 15.05.2018 METRO 2025, Warsaw: Demonstration of FreshIndex functionality as part of the METRO 2025 workshop on food innovation including monitoring for a meat transport from Warsaw to Germany. Internal testing as part of the METRO 2025 workshop on food innovation for a meat transport from Warshau to Germany.

A first interactive Demo application can be downloaded at:
https://play.google.com/store/apps/details?id=com.tsenso.monitoring&hl=de

2.4.2 Social Media

Since November 2017 tsenso has started to promote the FreshIndex as a new alternative to the food expiry date in its social media channels:

MEDIA CHANNEL	PLANNED FREQUENCY	TOTAL # POSTS
TWITTER	2/week	65
FACEBOOK (B2C)	Weekly	16
FACEBOOK (B2B)	Weekly	10
NEWSLETTER	6 / year	3
LINKEDIN	Monthly	1

The use of Facebook was discontinued in March 2018 as Facebook has lost its credibility in the European market due to several data protection scandals. Tsenso started using LinkedIn as a professional alternative to Facebook in April 2018.

https://twitter.com/tsensocom?lang=de
https://www.facebook.com/heutewasbesonderes (consumer targeted)
https://www.facebook.com/tsenso.gmbh/ (B2B targeted)
www.instagram.com/accounts/signup
https://www.linkedin.com/company/tsenso/?originalSubdomain=de

A first interactive Demo application can be downloaded at:
https://play.google.com/store/apps/details?id=com.tsenso.monitoring&hl=de

2.4.3 Global sustainability movement

In our efforts to fight global food waste, we believe that in the long run an optimisation of today's food safety legislation is needed.

Today's expiry dates are defined in the sole responsibility the manufacture based on the product and manufacturing details plus assumed future storage conditions. Due to the fact that the true future storage conditions cannot be known, significant error and safety margins have to be subtracted from the true possible product shelf-life to assure food safety on most cases, leading to a significantly reduced food shelf-life. In many cases, the manufactures reduce the stated expiry dates on the products even further due to marketing and profit considerations.

The FreshTag proposal has been inspired by the universal applicability of the TagItSmart platform. We see the potential that the smart tags of the TagItSmart platform and the tsenso self-life prediction algorithms can become the prototype to new, dynamic, measurement-based expiry dates and an optimized data-driven EU food safety legislation.

The module does not calculate a new best before date. The best before date is printed on the product in the responsibility of the producer, guaranteeing that this product has the best

quality until the stated day. In the countries we are active, Germany, France, Hungary and UK, products can still be used and sold even after the best-before date. The FreshTag modules calculate an additional date until with the product is hygienically safe to eat. The hygienic limits used inside the module are in accordance with the EU regulations 852-2014 and 853-2014 as well as EC 2073-2015.

There are other projects that aim to disrupt the food safety market (http://www.is-it-fresh.com/index.html, also http://fssp.food.dtu.dk/) The FreshTag approach shows the best cost per use and is more flexible in its possible use cases, as we do not depend on a specific temperature sensing provider. As will be pointed below, tsenso has successfully acquired a follow-on funding and is determined to bring the FreshIndex to a successful commercial product in order to reduce global food waste and improve sustainability.

Section 3 - Resources

3.1 Resources Deployed

The resources consumed in the project are of four categories:

- Manpower = salaries
- Travel expenses
- Scientifice work for the development of the microbial food model, most dominantly lab cost for University of Bonn and Wageneingen.
- Indirect costs for infrastructure and consumables, not to be detailed as covered by a proportional contribution

3.1.1 Personnel costs

The project involved:

- Dr. Matthias Brunner, Project Manager
- Rahul Tomar, Implementation
- Dubravka Fleck, preparation of food modelling activities
- Octavio Glorio, Big Data architect, since 01.01.2018

CALCULATION OF PERSONNEL COSTS

	Hours dedicated to project	Cost €/h	Personell cost
Dr. Matthias Brunner	200,18 h	49,00	9 808,82 €
Rahul Tomar	416,00 h	49,00	20 384,00 €
Dubravka Fleck	102,00 h	20,00	2 040,00 €
Octavio Glorio	240,00 h	49,00	11 760.00 €
TOTAL	**958.16 h**		**43 992,82 €**

Figure 9: Calculation of personnel costs

3.1.2 Travel expences

The costs of the already booked flights for the field trial planned for 12.04.2018 have been charged to the project budget as the cost have occurred and the cancelation of the trial as not within the area of resonsiblitly of tsenso.

CALCULATION OF TRAVEL COSTS

WHO	Start	End	Where	Why	Costs
M. BRUNNER	08.09.2017	09.09.2017	Vaasa	TagItSmart Kickoff	867,45 €
M. BRUNNER	09.10.2017	10.10.2017	Lausanne	Alpine Venture	362,89 €

				Summit	
M. BRUNNER	27.10.2017	27.10.2017	Düsseldorf	Sammelrechnung für PKW	215,87 €
O. GLORIO	30.11.2017	01.12.2017	Stuttgart	Teilnahme Team Treffen	205,35 €
D. FLECK	30.11.2017	01.12.2017	Stuttgart	Teilnahme Team Treffen	330,25 €
GLORIO	14.02.2018	16.02.2018	Stuttgart	Release of module	255.43 €
FLECK	15.02.2018	17.02.2018	Stuttgart	Release of module	143.80 €
M. BRUNNER	15.04.2018	16.04.2018	Warschau	Internal field trail	540.00 €
R. TOMAR	12.04.2018	14.04.2018	Novi Sad	Field trail	280.00 €
R. TOMAR	01.05.2018	02.05.2018	Novi Sad	Field trail	443.00 €
TOTAL					**3644.04 €**

Figure 10: Calculation of travel costs

3.1.3 Other direct costs

For the support of the development and validation of our food model cost of € 5.102,- occurred.
As the total project costs exceed the maximum fundable amount, the costs for sensors during the field trial where not charged to the project budget.

3.1.4 Total costs of the FreshTag Extension Projects

The total costs incurred for the project are:

EXTENSION COSTS INCURRED

COST CATEGORY	Budget according to SEC	Cost incurred	%
1. Personnel	49 920.- €	43 992,82 €	88 %
2. Travel	6 000.- €	3644.04.- €	61 %
3. Food modelling and Lab testing	5.000.- €	5.102.- €	102%
TOTAL	**60 920.- €**	**52 738.86 €**	**87 %**

Figure 11: Summary of extension costs incurred

3.2 Further development and exploitation

The FreshTag project was acknowledged as a big success by the managing partner of tsenso as well as the trial partner UniverExport. We hope to continue the successful collaboration with the TagItSmart companies even after the end of the project with future joint grant applications.

Tsenso will continue the development of the FreshTag module. As funding for the next development stage, a research project by the German Ministry of Education and Research (BMBF) was successfully acquired. During this follow-on project, the FreshIndex approach will be broadened and its industrial suitability will be increased. The aim of the research project is to prove the gapless monitoring of pork meat transport and its freshness evaluation for the German pork supply chain of Metro Cash & Carry, Germany.

The partners of tsenso during this project will be:

- Metro Cash & Carry, Germany:
  Metro is a leading international specialist for wholesale and food trade. Metro significantly supports tsenso during the project in order to increase the transparency and security in the supply chain. This is done by providing the hygiene data of the manufacturers and the actual storage conditions measured. This will make an important contribution to the reduction of food waste.
- GS1 Germany
  the leading standardization agency for commerce globally accompanies the development and implementation of open, cross-industry, globally valid standards. Within the framework of the project, GS1 Germany will examine, among other things, the degree to which a dynamic shelf-life criterion can be mapped in the globally existing GS1 portfolio and prepare necessary extensions of the standard for possible release if necessary.
- Arconsis GmbH:
  Acronsis is a growing SME and a strategic partner for innovative mobile business solutions and IT services in the areas of "Adaptive Enterprise" and "Mobile Enterprise"
- University of Bonn
  The team of PD Dr. Judith Kreyenschmidt (University of Bonn) has been researching for years in the area of food safety in order to reduce the committees along the supply chain. With this results, the development of the FreshIndex is supported significantly.
- Hochschule Bon-Rhein-Sieg
  The research group for Business and Consumer Informatics by Prof. Dr. Gunnar Stevens at H-BRS is characterized by the fact that it considers environmental and consumer informatics from a Praxeologischen perspective.