Screening of market needs for CHILL-ON technologies;

SWOT analysis by CHILL-ON partners and surveys among stakeholders

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PREFACE

This report summarises activities of the ASCS research group at UoI in the CHILL-ON project in WP 6 - Dissemination and training, Task 6.5.2 on “screening of usability and needs”. The outcome is a basis for the development of the „Business Strategy” based on the project’s results (Annex to Deliverable D6.10). Funding from the European Commission (FP6-016333-2) and input from the project’s partners and the various stakeholders is greatly acknowledged.

Project no.: FP6-016333-2
Project acronym:CHILL-ON

Project title: Developing and integrating novel technologies to improve safety, transparency and quality assurance of the chilled/frozen food supply chain – test case fish and poultry
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Thematic Priority: Food Quality and Safety
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Duration: 54 months

HÁSKÓLI ÍSLANDS
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Summary in English:	The view of CHILL-ON partners and stakeholders on the potentialities of the CHILL-ON technologies to enhance quality, safety and traceability in food supply chains is summarised herein. The aim was to identify the usability of the developments, which were made in the project, and to further establish their potential value additions and feasibility to meet the needs of end users of the project outputs. Analysis of CHILL-ON partners' views, regarding internal strength and weaknesses of the scientific achievements and technological developments and external opportunities and threats, is an input to the „CHILL-ON Business Strategy". Focus group activities, interviews with stakeholders and surveys performed during the last two years of the project have been summarized to obtain a vision for commercialization of the CHILL-ON project's traceability and monitoring tools, the optimized and/or best practice chilling protocols and novel packaging concept.Furthermore, implementation and validation of the CHILL-ON technologies in field trials in the last year of the project have demonstrated the functionality and benefits of the CHILL-ON project's technologies and identified where further research is needed. The main conclusions on the need of the food supply chain, stakeholders and retailers have been summarised and recommendations have been put forward on activities after the project's successful completion. These include feasible marketing approaches and further research and training activities for potential users of the knowledge produced within the project.		
English keywords:	Traceability, information technologies, SWOT, fish supply chains		

Contents

1 SWOT ANALYSIS

A SWOT analysis of the CHILL-ON project's results and developed technologies was performed to gain insight into the partners´ opinions on training, dissemination, exploitation, implementation and development of the CHILL-ON business strategy.

The risk that results from research projects are not exploited involves factors related to the market willingness to implement the solutions, such as:

- *the product or technology is too expensive*
- *the performance is below the needs of market*
- *better alternatives exist on the market*
- *insufficient demand on the market*

These may also be issues outside the consortium, such as:

- *impact of developments on the market on the exploitation potential of the anticipated project results;*
- *impact of the development of other technologies solving the same problem or addressing the same market;*
- *impact of legal or normative requirements or needs, or of emerging "de facto" standards*
- *issues such as insufficient trained staff, lack of acceptance by society, etc.*

These may include technical issues, such as feasibility of manufacturing, and economic issues, such as doubts on a specific technology's chances to be cost-competitive (EC FP6 website).

1.1 METHODS

A template for SWOT analysis and guidelines were sent to all WP leaders in June 2009 (see Annex I). The input was collected from partners in June-August 2009. Although, only four partners contributed, their background was representative for the interdisciplinary partnership in CHILL-ON and therefore this analysis is considered a valuable input for the business strategy. Further follow-up on the SWOT analysis with other partners of the CHILL-ON project was not pursued. Instead, efforts were made to approach the stakeholders in the chain by focus group activities and questionnaire surveys.The comments from CHILL-ON partners on the analysis of internal strengths and weaknesses, and external opportunities and threats, have been categorized according to the conceptual application of the technologies as follows.

1.2 RESULTS SWOT ANALYSIS

INTERNAL

STRENGTHS

Traceability / Supply chain management

- Handling and conditions of the product known at each step in the value and logistic chain. The opportunity is offered to survey and manage the product from A to Z.
- Transfer of data from one system to another appears to be relatively simple.
- Can track and store all kinds of information, events, measurements, etc., which can be transformed into 'value' information for potential clients.
- Many innovative modules, such as QMRA, SLP, DSS and new technical solutions like qPCR rapid test kits, RF-TTI and TTI/OnVu labels that will differentiate the CHILL-ON from other traceability systems in terms of pertinence and reliability of information.

Quality and quality assurance

- CHILL-ON consists of a network of specialists and knowledge on characteristics of supply chains of fish and poultry and the inherent product quality factors to provide basis for quality management of food supply chains.
- CHILL-ON has a widespread approach. If companies have concrete challenges that they want to solve in the field of quality management for chilled food, they can collect information very quickly and adapted solutions can be developed.
- Industrial guidelines on cooling technologies and packaging concepts
- Models for prediction of remaining shelf life and risks for consumers
- If the shelf life prediction indicates reduced shelflife, this is recognized in time to save the product, or a part of its value, through a remedial action.
- Commercial smart labels (OnVu) that are adapted to the spoilage rate of chilled fish and poultry give clear signals related to the quality or remaining shelf-life of the products, either for the consumer or the chain regarding incoming goods.
- Rapid detection of spoilage bacteria and pathogens.
- The added information on shelf life and risk for consumers increases trust on the customers' behalf
- Regarding the management of quality relevant data, a big set of different functionalities (models, hardware and software) have been integrated into one concrete solution. This gives potential customers an overview on how the combination of different technologies and concepts can improve quality management.

Safety

- Increased risk for consumers recognized in time to perform microbiological analysis in order to prevent consumer poisoning.
- PCR kits available for rapid analysis of pathogenic bacteria.
- Help design the HACCP (the QMRA is used along with the results of the temperature mapping and developed models to determine the limits at the CCP to ensure that the shelf life and the risks for consumers will be acceptable).
- Help the periodical verification of the implemented HACCP.

INTERNAL

WEAKNESSES

Traceability and supply chain management

- Many other dedicated traceability systems available on the market (need to demonstrate differentiation features).
- The combined technology solution is not ready for implementation as a generic solution.
- Not all the solutions are generic, which means that cost saving and fast adaption to concrete requirements of customers, cannot always take place.
- If a customer wants to have an integrated solution, for e.g. the optimization of cold chain management after the project is finished, he/she must speak with many partners.
- Real time data on temperature variation in the supply chain required (this should be viewed as a requirement rather than a weakness, however, some SC actors may view this as a weakness).
- Cost of 'CHILL-ON' solutions may become perceived as too high to be applied in real business.
- Cost/benefit has to be carefully estimated in terms of return on investment for potential users. For a successful launch as a commercial application, this would be the key element.
- Field trial partners have often changed in the CHILL-ON project. The field trial tests cannot show for all results on sustainable benefits because of the lack of customer requirements.

Quality and safety assurance

- Some developments are very innovative and it will take a longer time before they are market-ready or will be customized for specific chains.
- Two microbiological tests at different times, e.g., day one and day two, are required in order to determine the lag phase (the models can work with the lag phase that is determined from the laboratory experiments, but in order to increase the accuracy, a calibration for each lot may need

to be performed; the field tests should show how important the calibration of the model in the supply chainis).

- The QMRA requires historic data in order to estimate the probability for finding the relevant pathogens in the supply chain.
- A thorough investigation on the interaction of QMRA and HACCP requires time. Once the HACCP-QMRA system is operational in the supply chain, ideally, the analysis will take part during one year.

CHILL-ON consortium / Project management

- The bottom line given in the project is to develop commercially exploitable and marketable products. However, there is incapacity (humanly and financially) within the project to formulate a clear message to the market on the meaning, purpose and advantages of 'CHILL-ON'.
- No chain is stronger than its weakest link. Some of the technologies have not achieved to provide the required solutions and components that are essential to arrive at a successful outcome.
- Coordination of the entire project is criticised for lack of focus, where trivial details sometimes take too much attention and time from real strategic and operational issues.

CHILL-ON consortium / Dissemination and market awareness

- CHILL-ON dissemination of the project's activities and news items on the potentialities of the CHILL-ON technologies on the website are scattered and there are too few articles in international trade magazines.
- Clear messages on advantages, limitations, measurement accuracy and benchmarking of the CHILL-ON technologies against other technologies are still lacking.
- Own 'CHILL-ON' certification using a label could have been valuable, but this was not of interest to CHILL-ON partners and an incentive to develop a common business plan for the outcome of the project did not exist.
- Serious lack of commercial consciousness and marketing awareness within the project itself. This must be considered as a major handicap.

EXTERNAL

OPPORTUNITIES

Innovative solutions for the supply chain / Added value features

- Quality issues are becoming more and more inter-organizational issues. Besides measureable quality issues of the product, like colour and weight, some other quality issues regarding corporate responsibility or sustainability will become more important in the future. For these challenges, predevelopments supported through the CHILL-ON project have taken place, which will help companies

to improve in these fields of interest => Traceability solutions with additional value information on products.

- Offers new possibilities to communicate and market products with values that were difficult to obtain before (origin, sustainability, methods, carbon footprint, etc.). For niche marketing, this could be a strong selling point.
- Scientific knowledge on optimized handling and influence of temperature on the shelflife of products, thermal properties of products and packaging and details on the conditions in the supply chain can offer a possibility of finishing the processing in the country of origin in adapted packaging solutions per market segment, which in return will expedite the transfer (quicker logistic) to the point of sale where the consumer makes his/her choice.
- Could facilitate and strengthen fish farming activities in areas and regions that today are considered to be too far from the consumer markets.
- A holistic traceability and information system in the supply chain may improve customer relations by stronger ties and integration within the value and logistic chain. Exchange of information could be beneficial and probably turned into a win-win situation with subsequent cost reduction and increased level of reliability.

Supply chain management/Safety and traceability

- Legislation can be one main driver for innovation and changes in the market. Regarding food safety, the EU is focusing more control principles and framework legislations. That means, in very general terms, that the main responsibility for production of safe products lies within the companies themselves and legislation won't be the main driver for innovation.

Supply chain management / Quality assurance

- Where the industry has problems controlling the temperature in the supply chain, a timely warning that the lot has a shorter shelf life than usual would be a real benefit to support decisions for supply chain management.
- Where the industry would like to extend the shelf life of their products, if information from laboratory experiments show longer shelf life than in the supply chain. The real time data from the supply chain, combined with the SLP module, will provide answers of why the shelf life is not as long as it could be and what possibly can be done to achieve the longer shelf life.
- Alternative use of DSS-QMRA/SLP as an offline/non-destructive tool for checking the feasibility of different transport routes/modes (i.e. run expected temperature profiles against known product models and obtain results on expected shelf life).

- Where the industry wants to achieve an advantage with respect to the competition by providing to the customers accurate information on the shelf life and risks for consumers.

Supply chain management / Economic factors

- Offers reduction in administration (quality) cost by reducing paperwork and redirecting focus towards surveillance, security and prevention.
- A clear economical possibility of reduction in cost of bacteriological analyses.
- Increased efficiency by reducing waiting times, such as laboratory results, and improving fluidity within the value and logistic chain.
- Possibility to anticipate and react (and optimize the value) if something goes wrong, with subsequent reduction in potential product waste, which consequently would mean enhanced revenue management.
- Users may be able to reduce the level of stock and increase efficiency of the working capital.
- Could be of interest to certification bodies (such as IFS and BRC), official health authorities and makers and suppliers of software systems for the food processing industry.
- Could reduce the impact on seasonality in fishing of wild fish, and subsequently increase the value of the catch.
- Product recall procedures become either obsolete or can be moderated. The risk of considerable financial damages or loss of image, by applications of such procedures, can be reduced significantly.
- Is very likely to offer higher profits and returns if an increased proportion of seafood harvest (farmed or wild) is offered to consumers as fresh, instead of long shelf life conservation methods (frozen/salted/canned).

Training / Dissemination of CHILL-ON technical solutions and knowledge

- Training in the CHILL-ON technologies may enhance their marketability.
- The inspection agencies => introduce the potential of the CHILL-ON technologies.
- Lack of knowledge and understanding of the potentialities of the CHILL-ON technologies within the industries=> Training in marketable solutions (optimised chilling, packaging concepts, TTIs , RF-TTI, PCR test kits for bacteria, T-sensor, MMU,TRACECHILL software -T&T, GIS, OLMC, DSS).
- Lack of knowledge within the supply chain => Training regarding the potential of CHILL-ON technologies to improve supply chain management in the entire supply chain and enhance transparency.

EXTERNAL

THREATS

Markets / Competition / Benchmarking

- Many different competing solutions already exist on the market without any clear differences or visibility of functioning for potential clients and markets.
- It is a challenge in the CHILL-ON field trials to show that results are ready for the industry and to create references.
- Failure to deliver a clear message to the market on the meaning, purpose and advantages of CHILL-ON. Clear messages on advantages, limitations, measurement accuracy and benchmarking of the CHILL-ON technologies against other technologies are lacking.
- Can diminish credibility with an absence, or inadequate definitions, of key values and how they are calculated, for example, shelf life and other important marketing trends of environmental concern like 'Carbon footprint'.

Cost / Benefit

- Where the industry does not want to invest, does not want to recognize that there is a need for improvement and/or doesnot see the added benefits of adapting CHILL-ON technologies.
- Actors are not willing to share information (lack of trust and transparency in the supply chain), i.e. retailers are reluctant to show temperature recordings to their customers.
- The industry has shown an interest in the results but an easy cost-benefit analysis cannot be made because improvements in quality often have qualitative effects instead of quantitative effects, which show cost savings. This is not only a CHILL-ON problem, but a general problem for everybody who is working on quality improvement.
- An analysis on the effects of using the results of CHILL-ON can only take place in close discussion/ collaboration with companies who are interested in the results.

1.3 CONCLUSIONS SWOT ANALYSIS

The main results of the CHILL-ON partners' views on internal strengths and weaknesses, and external opportunities and threats, are summarized as follows.

Strength was considered to be the main potential of the CHILL-ON concept to enhance supply chain management, traceability, quality and safety in the supply chain and to provide added value in marketing features. The interdisciplinary network of specialists within CHILL-ON, with knowledge on the innovation potential and functionalities of CHILL-ON technologies and the characteristics of supply chains of fish and poultry, including the inherent product quality factors, was mentioned as a strength factor to provide a basis for holistic quality management of food supply chains. The individual CHILL-ON technologies that can

provide information on product temperature and shelf life in real time and verification of quality were also considered the project's strengths and of interest for the industry.

Weaknesses regarding the performance of the CHILL-ON technologies as market ready solutions were mentioned, as well as the lack of motivation of the CHILL-ON consortium to pursue market opportunities. Difficulties to demonstrate the cost/benefits of the technologies for the market were encountered. The main reason given was that some of the technological solutions are not generic and will need to be adapted to customer requirements. This was not achieved within the project and one reason mentioned was the fact that food industry partners often changed during the project's timeline. The valuable learning experience obtained in the implementation phase in the field trials during the final months of the project cannot be followed upon since the project is coming to an end.

Threats that were identified were associated with economic factors, for example, technologies might be too expensive, a lack of interest in the market to implement the solutions exists, competition from better alternatives on the market and/or insufficient demand on the market. Benchmarking the performance of the CHILL-ON technologies might be below the needs of the market and clear messages on costs and benefits are lacking.

Opportunities were generally recognized as immense in relation to innovative solutions for the supply chain and added value features, such as providing detailed information on products' conditions, handling, origin, shelflife, risks for consumers and derived values, like calculation of carbon footprint, to meet demands on environmental issues and to enhance the competitive advantage of companies. Scientific knowledge on optimized handling, chilling and packaging concepts can be exploited for training in the industry and to motivate innovation in processes and products to help companies in developing new marketing opportunities. By receiving timely warnings if the temperature is out of range and/or shelf life may be reduced, actors can perform remedial actions. As a result, more effective supply chain management can be achieved, as well as reduced waste and more sustainable and economical operations.

2 MARKET NEEDS

To guide the implementation and further exploitation of the CHILL-ON technologies in the fish and poultry supply chains, the view of various stakeholders was obtained during the project to underpin the marketability of the technologies.

Focus group activities have been carried out in the CHILL-ON project in connection with project meetings[1] and in field trials in the cod[2]and salmon chains. The emphasis in the last years was on organizations for different groups of users (inside and outside fish and poultry) that already use chain information systems, to gain insight into the experiences of the supply chain actors and to probe their views on the need for technologies to facilitate information flows of data on traceability, safety and quality[3]. The aim was also to obtain the view of retailers to extend as much as possible the available requirements in areas where information is considered lacking.

The preparation of questionnaires and frameworks for discussion in focus groups included an initial mapping of user requirements (Annex II) and an introduction of the CHILL-ON concepts,potentialsand implementation. Posters and presentations about the project from international meetings were used as a background to introduce the CHILL-On concept.[4,5,6,7]

CHILL-ON technologies are aiming to provide supply chain actors with tools to monitor HACCP (Hazard Analysis and Critical Control Points) and facilitate the implementation of traceability, safety and quality measures according to legal and commercial requirements. The concept of the TRACECHILL system is to tackle the most crucial points within a full supply chain: continuous temperature monitoring, temperature abuse identification, detection of microbial food contamination and quick tracking and tracing of products. The challenge is to translate the output of the technologies and the acquired information in terms of product quality, safety and transparency (see Figures 1 and 2 and Table 1).

[1] Moypark 2008 focus group meeting with stakeholders in poultry supply chains
[2] Westman Isles – Stakeholder meeting – fish supply chain Nov 2009 (Minutes from the meeting)
[3] Johannesson G.Th. and Gudmundsdottir, H. 2010. CHILL-ON –Summary from a focus group study. Report for Laboratory of Applied Supply Chain Systems, Social Science Institute, University of Iceland, May 2010
[4] Bogason et al., 2009. Novel technologies to improve safety and transparency of the chilled food supply chain. Poster presented at Innovation in the Nordic Marine sector, organized by Nordic Innovation Center, Reykjavík May12, 2009.
[5] Ólafsdóttir, et al. 2009a. Implementation of novel technologies in field trials in the fish and poultry supply chains. 3rd TAFT Conference15-18 Sept 2009, Copenhagen, Denmark
[6] Olafsdóttir, G. and Bogason, S., 2009. Improved competitiveness through optimization of cold chain communication. Pre-conference Workshop – EFFoST, Budapest November 10th 2009
[7] Ólafsdóttir et al. 2010a. Improved efficiency and real time temperature monitoring in the food supply chain. In Proceedings of 1st IIR International Cold Chain and Sustainability Conferences, Cambridge, UK, 29th - 31st March 2010, IIF-IIR, France, 2010. ISBN 978-2-913149-75-5

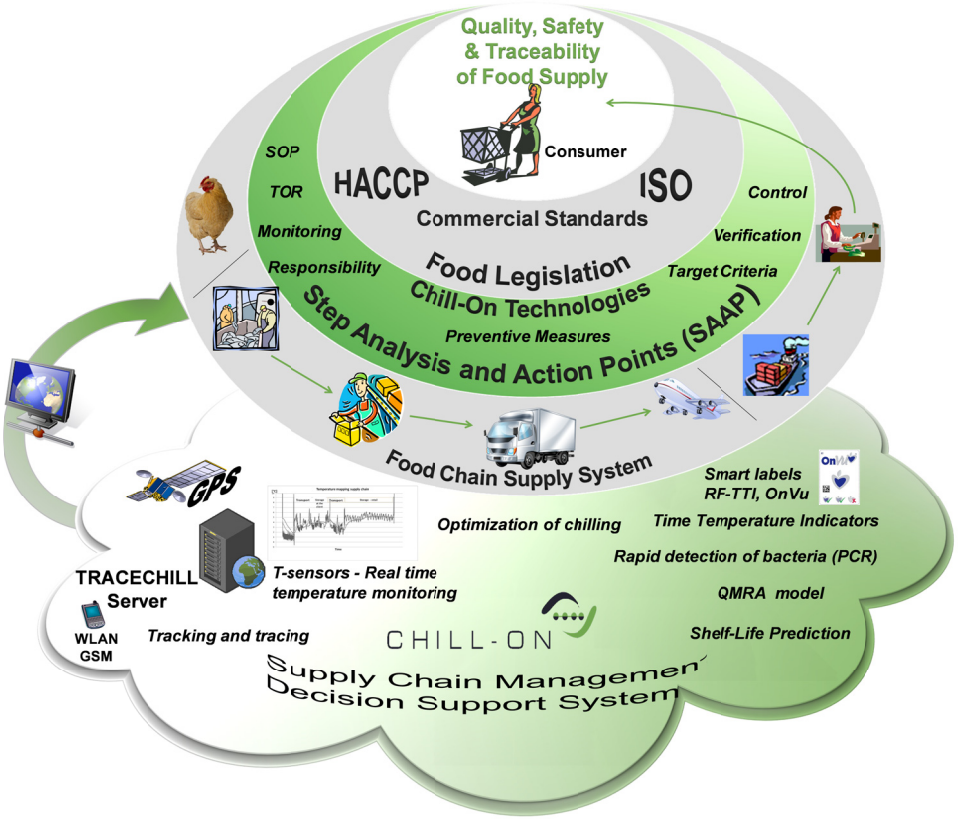

Figure 1.Overall vision of the implementation of the CHILL-ON technologies in the food supply chain (From: Ólafsdóttir et al., 2009a)

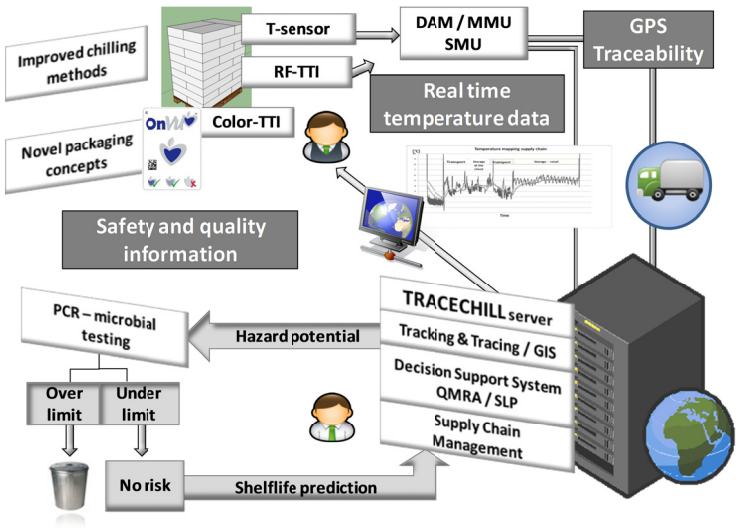

Figure 2. CHILL-ON conceptual approach to monitor quality, safety and traceability in food supply chains (From: Olafsdóttir et al., 2010a)

Box 1 **The developed CHILL-ON technologies include the following concepts and outputs aimed at enhancing the quality, safety and traceability in the fish and poultry supply chains**

*Improved chilling and packaging concepts - **Guidelines for food industry***

- Information on cooling rate of raw material in different chilling media and economic aspects
- Impact of environmental temperature and temperature fluctuations on the product temperature inside EPS packaging in different supply chain scenarios (thermal models)
- Information on the effect of temperature and time on the **quality and shelflife** of products

*Equipment for monitoring temperature and geographic location, data acquisition and data transfer - **Technologies (hardware)***

- Temperature sensors / T-sensors /RF-TTI for **temperature monitoring** of ambient conditions and inside packages to monitor product temperature in real time
- Mobile and Stationary Management Units (MMU/SMU)) for data acquisition and data transfer(Data Acquisition Management (DAM))
- **GPS location**

*Predictive microbial models on quality and safety **QMRA/ SLP –Models*** (stand alone – or input used in DSS in TRACECHILL)

- **Quality** evaluation based on **shelf life** prediction models, which apply real time temperature data and initial microbial load of products as input.
- **Risk assessment -** quantitative microbial risk assessment model - needs to be adapted over long time within companies.

*Rapid microbial detection by **qPCR tool kits*** (stand alone – input used in TRACECHILL)

- Results on microbial counts within 4-5 hours
- Detection of specific spoilage organisms for **quality** evaluation and pathogens influencing **safety** of products
- Hygienic indicator bacteria

*"Smart" labels - **Time temperature indicators TTI´s*** OnVu™ (stand alone)

- Time temperature indicators that change colors according to time and temperature load
- The TTI´s are calibrated against **quality** deterioration of selected fish and poultry products,

*TRACECHILL server –**Software modules*** (input from hardware components needed)

- *The TRACECHILL combines the CHILL-ON technologies in a web-based system*
- *Online Monitoring Client* (OLMC), the user can **observe the temperature and location** of the product units via a web-based system TRACECHILL and apply the information for supply chain management
- *Tracking and tracing* (T&T) of units as part of the electronic **traceability** system
- *Geographic Information System* (GIS) provides information on the location of units in real time
- *Supply Chain Management* (SCM) software tool provides logistic information and linking the traceable units to temperature sensor data and data on location
- *Decision Support System* (DSS) based on an alert system, which is fed by time/temperature data and information on microbial contamination as an input to QMRA and SLP models. The alerts give **temperature warnings** and **real time prediction of reduced shelflife.**

CHILL-ON technologies can have an impact on economic and environmental values for food companies by supporting management decisions aimed at minimizing perishable waste and thus enhancing sustainability of the supply chain

2.1 STAKEHOLDER MEETING IN WESTMAN ISLES, NOV 2010

Industry requirements, based on focus group discussions at a stakholder meeting in Westman Isles on the potential implementation of the CHILL-ON technologies, were summarised as follows: „*Fish producers have shown great interest to be able to monitor their products in case something goes wrong in the supply chain, especially during transport to distant markets. The producer would then be able to intervene much sooner than is possible today and could thus direct the product either off the market if spoiled or to another production of less value with lower quality requirements. A very important aspect in today's supply chains is: who gets the blame when something goes wrong? Today, this is difficult to decide upon because of the blindness in the chains, where actors only see „one up" and „one down" in the chain as required by regulations.*

It is common in the fish supply chain that the producers are not responsible for the transport of products, but instead the transport is bought from a logistic company. Therefore, producers have limited control over the shipments and can only ensure consumer satisfaction based on trust in the logistics and the condition of the product at the time of shipping. In the typical supply chain of fresh fish from Iceland to markets in Europe, the processor receives information on origin, logistic details and condition of the catch from the previous link. Temperature is registered in the processing and quality control is performed before the product leaves the processing plant. Transport to market takes two to four days and includes both trucking and transport by air or ship. The logistic companies are commonly not interested in showing temperature monitoring data throughout the transport in food supply chains (Raab et al., 2009). This may be explained by various broken links in the cold chain related to handover points. For example, uncontrollable temperature fluctuations may occur during loading and unloading of airplane freight. Transport by ship may offer better temperature control which will result in consistent quality of products (Mai et al,2010)."[8]

[8] Ólafsdóttir G., Bogason S., Colmer C., Eden M., Hafliðason T., Kück M., 2010a. Improved efficiency and real time temperature monitoring in the food supply chain. In Proceedings of 1st IIR International Cold Chain and Sustainability Conferences, Cambridge, UK, 29th - 31st March 2010, IIF-IIR, France, 2010. ISBN 978-2-913149-75-5

2.2 FOCUS GROUP – STAKEHOLDERS IN ICELAND, APRIL 2010

Different views on traceability systems in general and the Chill-On technologies in particular were addressed in a focus group discussion including representatives from all steps in a supply chain for the export of fresh and frozen fish from Iceland. The focus group was conducted by the Social Science Institute of UoI.[9]According to the views of representatives from the fish supply chain in Iceland, the most prominent potentialities and common barriers for implementing the CHILL-ON technologies are listed in Table 1.

While participants could see various benefits related to electronic traceability systems, they were in general not confident that they would implement such systems. However, they agreed that the technologies could simplify record keeping. Recording of information between different handover points absorbs much time. If one could implement a system, into which each unit would be registered and that a record would be attached to each unit in the entire supply chain, it would have immense value for the management of the supply chain.

Table 1 Potentialities of the CHILL-ON technologies and barriers for their implementation

Potentialities of CHILL-ON technologies
Secure transport / verification
Assist insurance companies / liability
Enhanced quality control / shelf life prediction /rapid microbial detection
Could simplify record keeping /Audits
Enhanced supply chain management
Barriers for implementing CHILL-ON technologies
Could slow down delivery
Practical/ technical issues (placement and retrieval of tags)
Definition of "the problem" (is the "problem" a problem?)
Lack of trust between actors / Not willing to share data
Weak use value for the business
Increased costs
Not much value for consumers

It was pointed out that the value of this kind of system for frozen fish supply chains would be different from chilled fish supply chains. The frozen products are much more robust and this kind of system would not necessarily add more information than is currently available. It was a common view that a more effective

[9] Johannesson G.Th. and Gudmundsdottir, H. 2010. CHILL-ON –Summary from a focus group study. Report for Laboratory of Applied Supply Chain Systems, Social Science Institute, University of Iceland, May 2010.

supply chain management system would be needed for chilled products, where the transport is often regarded as the weakest link in the value chain. The insurance sector was more interested than the other participants since they saw benefits regarding verifications and when appointing responsibility to actors in case of disputes. The interests of other actors depended very much on the final design and the expense of the technology.

Numerous barriers were mentioned with regard to the feasibility and implementation of the entire system. An actor who is exporting fresh fish emphasized that the benefits of an electronic traceability system depend on how expensive it would be. This business is very sensitive for delays and any tracking system should not be implemented if it would slow down the transportation process.

Numerous practical issues also came up, such as the actual size of the tracking device, whether it is reusable or not, and how much time it would take to retrieve it if it were reusable. If it were light and inexpensive, that would surely make it easier to implement. Even issues regarding airport security were mentioned as a possible barrier.

The main barrier was the cost and a central question was: Who is to pay? This was related to the definition of the problem that technology is to solve. Is it really a problem? According to the group, most of the things that the CHILL-ON technologies address were not problematic and the concept as a whole was not feasible to implement.

⇒ *The processors were, however, interested in the stand alone solutions for quality assurance, like rapid detection of bacteria, temperature monitoring and shelflife prediction, but mainly to perform internal checks and facilitate audits, i.e. not to implement for daily applications*.

3 PREPARATION OF QUESTIONNAIRES - SELECTION OF ATTRIBUTES

Enablers and barriers for installment of traceability systems in the food sector can vary depending on the type of sector and processing, position and role of companies in the supply chain, size of companies and location.It is likely that similar attributes characterize enablers and barriers for implementing electronic traceability systems, which also include real time monitoring of temperature and data on quality of the products. However, the actors may perceive the benefit of the added service differently, and therefore, it is of interest to explore their views. When preparing the questionnaires in the CHILL-ON project, justifications for selection of attributes for key drivers and main barriers are based on literature review and the views of stakeholders, which were obtained in focus group meetings in the CHILL-ON project.

3.1 Drivers

Drivers behind traceability system implementation have been studied for various food businesses and common factors have been identified. As an example, in the case of dairy processing, three principle factors were identified that are related to product problems, market drivers and legal/regulatory drivers (Table 1).

Table 1 Drivers for traceability implementation in dairy processing (Sparling et al., 2006).

Product problems	Market drivers	Legal/regulatory drivers
to reduce the risk of a product problem accruing	to meet customer requirement,	to reduce product liability,
to reduce recall impact	to reposition products	to meet regulatory requirements
to reduce risk of recalls	to increase share of the current market	
	to access newmarket,	
	to obtain higher product price	

According to experts from the field of food risk management in Europe, effective food and ingredient traceability systems have the potential to improve food safety, however, further improvements regarding harmonization of practices and pan-global legislation are needed (Kher et al., 2010). Any means that facilitate efforts to appoint liability to responsible actors in the chain in case of food safety issues or fraud would be of benefit for the whole supply chain. In the survey on the view of risk management experts from food safety agencies and those involved in research or in quality maintenance in the food supply chain, the main advantages of food chain traceability were seen in relation to more accurately tracing products in case of food safety incidences and product recall, liability of responsible actors, more reliable information

on product components (i.e. origin) and improvement of trust (Kher et al., 2010)[10]. This is in line with the benefits identified in voluntary traceability in various food and feed sectors in Italy (Banterle and Stranieri, 2008)[11]. The main benefits were seen through product differentiation, reduction of product recalls, identification of liability among the actors of the supply chain and supply chain management improvement. According to Doluschitz et al. (2010)[12], clear statements on cost, benefits and sustainability of developed IT systems are considered a prerequisite for acceptance in the industry.

The most common incentives for implementation of a traceability system according to a Chinese fishery processing company were product quality improvement, the need for healthy consumption and management improvement, while private and joint-venture enterprises also considered marketing drivers important, like potentials to meet the customers' requirements, to extend international and domestic markets and to differentiate products (Wang et al., 2009a)[13].

3.1.1 REGULATIONS

Regulations on food safety, traceability and industry practices based on GMP and effective HACCP plans, as well as implemented systems for tracking and tracing, are means to control food quality, safety and traceability for the consumers. Although legislation on food traceability has been in effect in Europe (EC Regulation No. 178/2002 (EU, 2002) and the US Bioterrorism Act PL107-188 (2002)), inefficient recalls of food products in connection with food safety scandals are still posing risk to consumers. With the ever increasing attention to food safety, the increased focus on a global, electronic traceability system has been inevitable. FDA has already implemented regulations on mandatory electronic reporting of potentially dangerous foods and online registration of food facilities. It is evident that both large enterprises as well as small companies will have to meet these regulatory requirements and invest in technology.[14]

The implementation of traceability and information systems may give various added benefits like more reliable information on product components and origin, more transparent record keeping and fewer errors in data handling. These are all factors that will support more efficient product recall with the safety of the consumers in mind as well as minimizing economical losses.

[10] Kher, SV, Frewer, LJ, De Jonge, J, et al. 2010. Expert´s perspectives on the implentatation of traceability in Europe. British Food Journal, 112 (3),262-174.

[11] Banterle, A. and Stranieri, S. (2008), "The consequences of voluntary traceability system for supply chain relationships: an application of transaction cost economics", Food Policy, Vol. 33 No. 6, pp. 560-9.

[12] Doluschitz, R., B. Engler, C. Hoffmann. 2010. Quality assurance and traceability of foods of animal origin: major findings from the research project IT FoodTrace. Journal für Verbraucherschutz und Lebensmittelsicherheit. 5:11–19.

[13] Wang F, Fu Z, Mu W, Moga LM, Zhang X. 2009a, Adoption of traceability system in Chinese fishery process enterprises: Difficulties, incentives and performance. J Food, Agric. & Env. 7 (2): 64 - 69.

[14] http://www.qualityassurancemag.com/Article.aspx?article_id=104516

3.1.2 ECONOMIC VALUES

Economic values are of major concern for businesses when evaluating the possibility to implement new technologies and the cost/benefit ratio is the main determinant. Numerous studies have pointed out that the benefits have to be reflected in better supply chain management to gain more profit, resulting in better quality of the products on the market, longer shelflife and less waste. Faster and more accurate recall of products is a real advantage. In general, values that contribute to an enhanced image of the company are of benefit for marketing. According to the study of Sparling et al. (2006)[15] in the dairy manufacturing industry, it was found that 60 percent of 130 companies' respondents considered that the benefits of implementing traceability exceeded the costs and 27.8 percent considered that the benefits exceeded expectations. Interestingly, after implementation of traceability, these companies' respondents perceived that improved perception by customers, regulators and consumers were the most important, while repositioning in current markets, obtaining higher prices and gaining access to new markets were somewhat unimportant.

Commercial standards (BRC, IFS and ISO 9001 and 22000) are implemented in many companies as a response to the requirements made by buyers to ensure the quality and safety of the production. However, these standards are not implemented in the entire supply chain, but mainly in the manufacturing companies. Commercial standards and retail schemes are important drivers for implementing new processes. These schemes are aimed at facilitating audits to verify a company´s performance based on traceability, quality and safety checks.

According to a recent paper on „Dynamics of the retail driven higher end spot market in fresh food"[16], the dynamics of certification schemes are argued. These schemes are characterized by processes of contraction (mergers), followed by relaxation (diversification). The paper concludes that the retail sector is the primary beneficiary of the shift towards a single premium spot market. For the remainder of the food chain members, it is less clear whether the overall effect is positive or not.

3.1.3 ENVIRONMENTAL VALUES

Environmental values and labelling of carbon footprint and food mileage, to present the concern for the environment,are becoming recognised as marketing tools. The concern for the protection of the environment, better utilisation of resources, less waste and organic production linked to green values are

[15] Sparling, D., Henson, S., Dessureault, S. and Herath, D. (2006), "Costs and benefits of traceability in the Canadian dairy-processing sector", Journal of Food Distribution Research Distribution Research, Vol. 37 No. 1, pp. 154-60.

[16] Koen Mondelaers, Guido Van Huylenbroeck, 2008. Dynamics of the retail driven higher end spot market in fresh food. Journal: British Food Journal, 110, 4/5, 474-492

very well acknowledged.However, more research is needed based on Life Cycle Assessment and validation of environmental indicators to substantiate environmental lables.

Although sustainability of production is commonly not well defined, there is interest in some companies to utilise sustainability, or rather the environmental indicators, as marketing tools. The response to these environmental supply chain challenges has been the use of market-led instruments to shape food supply sustainability and food consumption. The private corporate managers of supply chains among the large food manufacturers and retailers have led the approach to utilize a combination of standards setting and accreditation, backed by audits, traceability and labeling instruments that shift more responsibility to the consumer in the pursuit of policy goals. As a result, the retailers dominate the terms of trade along food supply chains since the buyers have imposed control and power over suppliers (Rayner et al, 2008)[17]. European retailers delivered in 2009 a voluntary environmental code of conduct where the retailers signing up to the code commit to a set of principles and measures aimed at reducing their environmental footprints (EU, 2009)[18]. Furthermore, large international businesses, such as Tesco, PepsiCo, Carrefour and others, have already started to label products as having lower carbon footprints during the production, packaging and transport of certain products.

3.1.4 CONSUMER VALUES

The consumer values,which are most often mentioned as determinants for buying behaviour, are listed in Table 1. For the consumer, price is often the main determinant when purchasing food, but shelf life, quality, freshness, taste and healthy and nutritious attributes are also of high value.

Environmentally concerned consumers and niche groups are looking at labelling and appreciating values like origin, green, sustainable and organic production. The consumers, however, may not be well informed about the definitions of the quality, safety and traceability concepts. Safety is often taken for granted, but the consumers' perception of food quality and safety appear to be interlinked and traceabilty is linked to both.These concepts may thus all influence the purchase decision of consumers (Rijswijk and Frewer, 2008)[19].

[17] Rayner, G., Barling, D., Lang, T. (2008) "Sustainable Food Systems in Europe: policies, realities and futures", Journal of Hunger & Environmental Nutrition, 3 (2 /3): 145-168.

[18] EU, 2009. Environment: Commission and retail sector launch Retail Forum to promote more sustainable consumption.

[19] Rijswijk, W., L. J. Frewer. 2008. Consumer perceptions of food quality and safety and their relation to traceability. British Food Journal. 110 (10): 1034-1046

Table 2. Attributes of key drivers for implementing electronic systems on real time monitoring of temperature and location of products and information on traceability, quality and safety

Regulations
More efficient product recall - food safety
Appoint liability of responsible actor (in case of food safety issues or fraud)
More reliable information on product components and origin
Improvement of trust
More transparent record keeping
Facilitates audits - verify company´s performance (traceability, quality and safety checks)
Economic values /Market values
Cost - Benefit
Supply chain management
Shelflife of products
FEFO v.s. FIFO
Less waste - More profit
Enhance the image of the company
Benefit for marketing
Faster and more accurate recall of products / reduce impact of recalls
Environmental values
Environmental labels (i.e. MSC, eco-labels, regional/ national/brand)
Origin
Less waste
Sustainability Indicators (i.e. Life Cycle Assessment , carbon footprint, food mileage)
Green values
Consumer values
Cost / Price
Labelling
Healthy / nutritious – impact on health and well being
Safety of products
Shelf life and quality of products
Sustainable production / Green values
Origin
Organic products

3.2 BARRIERS

The main attributes of the barriers that are identified for implementing electronic systems for real time monitoring of temperature and location of products and information on traceability, quality and safety,are the cost of the implementation, trust between actors and technical knowledge or skills of workers.

3.2.1 COST

Cost issues are of main concern as barriers. The installation cost, operational cost, lack of staff and more time consuming processes are all factors of importance when evaluating the cost/benefit of the implementation and the willingness to pay for new technologies. Cost sharing between supply chain actors

has been emphasised along with the role of governments to facilitate the implementation of standardised electronic systems,but othersnonetheless believe that industry driven initatives will be more succesful.
In focus group discussions with fish supply chain actors in Europe (IS), it was expressed that the industry was not interested in solutions that were imposed upon them and referenceswere made to the fact that the fish business is a very highly regulated industry, which is burdened by costly audits. These actors would therefore have to see concrete benefits of implementing an electronic traceability system. Arguments made to cost sharing among companies at different links of the supply chain have been reported and are based on the perceived benefits of traceability systems for different types of companies (Mai et al, 2009)[20].

3.2.2 TRUST AND COMMUNICATION

Lack of trust and communication in the supply chain between actors are commonly refered to as barriers for implementing new technologies. The common benefits for these actors are often not clear and therefore, there is lack of commitment. Barriers are also existingdue to actors not being willing to share information. However, this is dependant on the chain and the type of information that is being shared. A recent study on the effect of the food traceability system for building trust, underlines that uncertainty is due to fear of selling opportunities originating from lack of trust (Young et al. 2009)[21].

3.2.3 TECHNICAL ISSUES

Technical issues have been identified as barriers for implementing electronic systems. Supply chain actors may not all be aware of potential benefits of new technologies and lack of technical knowledge in companies may hinder the uptake of new technolgies. Practical constraints like difficulties in placement of remote sensors/tags on units (pallets or boxes) and difficulties in retrieval of these devices are often identified as barriers for their implementation. The demand is that the technologies/systems have to be as good as, or better than, current systems regarding accuracy and precision. Furthermore, the technologies need to be validated and they have to comply with standards and current legislations.
Other factors may also pose as barriers for the sharing of electronic temperature information as has been reported in the case of ERP implementation. These barriers were not technologyrelated issues, such as technological complexity, compatibility, standardization, etc., but were mostly concerned with organization

[20] Mai, N, Bogason, S.G., Arason, S., Árnason, S.V., Matthíasson, Th.G. 2010. Benefits of traceability in fish supply chains – case studies. British Food Journal, 112, 9, 976-1002.
[21] Young Chan Choe, Joowon Park, Miri Chung and Junghoon Moon, 2009. Effect of the food traceability system for building trust: Price premium and buying behaviour. Inf Syst Front. 11:167–179

and humanrelated issues, such as resistance to change, organizational culture, incompatible business processes, project mis-management and top management commitment (Helo et al., 2008)[22].

Table 3 Main attributes of barriers identified for implementing electronic systems for real time monitoring of temperature and location of products and information on traceability, quality and safety

Cost
Cost - Benefit
Installment cost
Operational cost
Willingness to pay
Time consuming
Lack of staff
Cost sharing of supply chain actors
Trust and communication
Lack of trust
Lack of communication between actors in the supply chain
Common benefits of actors not clear
Lack of commitment
Not willing to share information
Technical issues
Actors not aware of potential benefits of new technologies and systems
Lack of technical knowledge
Difficulties in placement of remote sensors / tags on units (pallets or boxes)
Technologies /systems have to be as good or better than current system
Accuracy and precision of technologies/systems
Technologies need to be validated
Have to comply with standards
Storage of data that is not processed and exploited is expensive

[22] Helo, P., P. Anussornnitisarn, K. Phusavat. 2008. Expectation and reality in ERP implementation: consultant and solution provider perspective. Industrial Management & Data Systems. 108, 8: 1045-1059.

4 QUESTIONNAIRE SURVEYS

Three surveys have been conducted in the project on the market need of the CHILL-ON technologies and the view of stakeholders regarding sharing real time information on quality, safety and traceability in the fish supply chain.

- Brussels Seafood Exposition - April 2010
- Web based survey on "Environmental awareness of stakeholders" - August 2010[23]
- Internet survey aimed at (potential) operators who are interested in the developed technologies – December 2010

The first questionnaire survey was conducted for stakeholders attending the Seafood Exposition in Brussels in April 2010. The aim was to obtain the view of the key commercial players in the fish supply chain regarding existing trust between the chilled chain actors and their willingness to share information. Secondly, the objective was to prioritize main drivers and barriers for implementing electronic information systems, including traceability and real time temperature monitoring systems and quality of products. The information obtained in focus group discussions along with literature sources, were the basis for selecting the attributes of key drivers and main barriers (Table 1 and Table 2) which were applied to formulate a questionnaire to further substantiate the focus group results. The main results of the Brussel survey have been introduced[24] and a detailed report is available [25] which will be published when a scientific paper on the results has been accepted for publication. The second survey was conducted in August 2010 to explore further the environmental awareness of Icelandic stakeholders and the need for information on environmental impact of products. The third survey is an on-line international survey which combines the content of the earlier surveys. The aim was to obtain significant results and study if there are differences according to countries or different markets.

[23] Ingólfsdóttir, G.M. 2010. Application of Environmental Indicators for Seafood. Final report for The Icelandic Research Council, University of Iceland, Laboratory of Applied Supply Chain Systems, ASCS-UoI Report, Sept 2010, 60p.

[24] Ólafsdóttir, G., Bogason, S., Hafliðason T., Guðlaugsson, E., Ómarsdóttir, I. l., Jóhannesson G.Th, 2010. Stakeholder views on implementation of information and supply chain management systems in the fish sector. 40th WEFTA meeting, Turkey, October 4-7th 2010

[25] Ólafsdóttir, G., Hafliðason, T., Bogason, S.G., Guðlaugsson E., Jóhannesson, G. Th., Ómarsdóttir I.L. Survey on views of stakeholders at the Brussels Seafood Exposition 2010. ASCS-UoI Report Dec. 2010.

4.1.1 STAKEHOLDER SURVEY IN BRUSSELS, APRIL2010

TRUST AND MISTRUST

The results of the Brussels survey confirmed the main results obtained in the focus group discussions. Trust was considered necessary for business and, therefore, it needs to be in place throughout the entire chain. However, some stated that they were not willing to share all information. In fact, when a question about potential mistrust was posed, it was generally agreed that mistrust can occur anywhere in the chain. This is an opportunity for Chill-on technologies to provide tools for verification of conditions and performance to enhance trust. The majority of the respondents agreed with the statement that sharing of real-time temperature data between actors would enhance trust and commitment in the fish supply chain. However, those who did not agree stated that temperature was already effectively controlled and monitored by using handheld devices or data loggers. The main concern was that sharing of electronic data would be too costly, too much extra work, would pose as an "annoyance"and would have no added benefits.

- ⇒ Proof and verification of critical temperature conditions was considered important in the case of a breakdown in the cold chain.
- ⇒ Easier to determine where the break in the chain had occurred if sharing of electronic temperature data was in place.
- ⇒ Verification of the geographic location (GPS) and proof of quality of the transport service were considered as benefits
- ⇒ All actors would gain by implementing real time temperature monitoring system, since quality of products could be guaranteed, but retailers would probably gain the most

MAIN BARRIERS

The findings from the survey verified that *cost was the main barrier* for installing an electronically based system that is capable of sharing real-time information on traceability data, GPS location, temperature and shelf life. The *cost-benefit ratio* was emphasized, as well as barriers regarding *installation and operation cost* and the short-term issue that it would be time consuming to have such a system implemented.

KEY DRIVERS

Regulations were mentioned most often as the key driver for implementing an electronically based information system. Consumer values were ranked in second place, where *quality and shelf life of products* were the key attributes. Thirdly, economic factors, such as a *cost-benefit ratio* and improved *supply chain management*, were considered important. Environmental issues were ranked last as important drivers for implementing new technologies. However, it was noted that the four choices given were highly dependent

on each other. Environmental issues were considered as marketing tools and important to enhance companies' image and to address consumers' environmental awareness and sustainability demands, mostly imposed by retailers.

4.1.2 ENVIRONMENTAL AWARENESS OF STAKEHOLDERS– SURVEY, AUGUST 2010

The results of an internet based survey for Icelandic cold supply chain stakeholders revealed that more than half of the respondents felt that their company recognizes the environmental impacts caused by their production system. It was commented that larger companies have a better understanding of their environmental performance than smaller companies have. The survey indicates that almost two thirds of the larger companies recognize their environmental impacts while half of the small and micro sized companies claimed to have this knowledge. It must however be noted that 82% of the respondents work for medium and large sized companies and only 18% are employees of micro and small sized companies.

Almost half of the respondents recognised the environmental indicator carbon footprint. Less than half of the respondents believe that environmental indicators can be of any significance for the Icelandic seafood industry. The majority of those who recognised carbon footprint see the potential of utilizing environmental indicators. The opportunity to use the indicators is mostly seen in marketing purposes, which is in accordance with the findings in the survey among stakeholders at the Brussels Seafood Exposition. Another significant factor is related to resource savings and waste minimization while the indicators are not found as important for the supply chain management.

The survey indicates that there is a demand for information about the environmental impacts of the seafood products. There seems to be a trend of increasing demand from buyers on environmentally sound operational procedures, especially since environmental awareness of retailers is increasing, rather than the public's awareness. The markets demand certificates of origins (mandatory), sustainable fisheries and to some extent, environmental labels, with MSC being the most demanded environmental certification label. With almost half of the respondents feeling the demand for environmentally labelling their products, it is a clear indication that environmentally friendly production is now demanded in mainstream markets, not only in niche markets. The survey results show that the main market, which demands the environmental information, is in northern Europe. This is in agreement with the Brussels survey results.

⇒ *When respondents were asked which factors were most important when it came to choosing the transportation phase of the supply chain, the results were clear. The quality and cost of the product are of highest importance for most of the supply chain actors*.

4.1.3 INTERNET SURVEY

The main aim of this survey, conducted in December 2010, is to provide quantitative results and to further substantiate the findings as well as increase knowledge of the needs of potential end users. This study is a part of a PhD project, which ensures that a manuscript will be prepared and submitted for publication as a part of the requirements for the thesis.

4.2 SUMMARY OF MARKET NEEDS

4.2.1 FOOD SUPPLY CHAIN REQUIREMENTS

Food safety and traceability have evolved to focus on the entire food supply chain and concentrate on building quality assurance into all elements in the value chain, from catch to consumer. It is no longer sufficient to focus on traceability and identify defective products, but rather to focus on prevention by optimized handling and monitoring all steps in the supply chain, including raw material sourcing, receiving, transportation and storage, processing, packing and distribution to retailers and consumers.

Real time *monitoring of temperature* in the food supply chain and *shelf life prediction* offer the possibility to make timely decisions in *supply chain management*. This ensures that food is distributed according to the expected shelflife and *losses can therefore possibly be prevented* if, for example, temperature has exceeded the acceptable limits, which would enhance the deterioration process of the products.

⇒ The objectives of the CHILL-ON project were set to meet these current demands

⇒ *The real challenge for the CHILL-ON partners is to translate the output of the technologies and the acquired information in terms of product quality, safety and transparency. Clear messages have to be given on how and where the technologies can be adopted to offer a positive return on investment in terms of increased benefits for companies.*

4.2.2 STAKEHOLDER REQUIREMENTS

Several stakeholder meetings and focus group interviews with food supply chain representatives have been conducted within the Chill-on project to gain insight into their experiences and to probe their views on the need for technologies to enhance traceability, safety and quality. Results from these meetings have highlighted the following:

⇒ Stakeholders need *applied knowledge and simple tools* to verify the quality, safety and traceability of their products according to regulatory and customer requirements.

⇒ Actors in the food chain *will only implement tools, which guarantee an added value for their operations.*

⇒ *The overall Chill-on concept appears to be too complex according to stakeholders. However, stand-alone solutions are promising and should be introduced gradually in the chain.*

4.2.3 RETAILER REQUIREMENTS

Success of the technologies, when implemented in the market, is highly linked to their abilities to provide evidence of values that are required by supply chain actors to *build trust in line with the consumers' perceptions of the product values*. The current focus on consumers is a consequence of the retail sector drawing on consumer demands to enhance their competitiveness and building trust, rather than consumers being active and expressing their demands. An interview with a marketing company, which is acting as a broker for fresh fish and fish products for the retailer market, confirmed that requirements made by big retailers, like Carrefour, Tesco and others, are becoming more demanding. Many retailers are leveraging information and asking for more detailed product information from suppliers as a way to gain consumer trust and to share information that they believe consumers are using to make purchase and lifestyle decisions. However, it was noted that it is currently difficult to ensure the validity of information on product's handling and conditions, since transparency is often lacking in the fish supply chain. The certification of origin is required by regulation, but information on environmental impacts is increasingly being asked for by the retailers. This information is needed to effectively differentiate their private label offerings and to build up eco-values in their brands and thus gain consumer credibility and trust.

⇒ *Opportunities for the Chill-on technologies include providing verification of performance in the supply chain as valid indicators of quality, safety and traceability.*

⇒ As an added value feature, information on environmental indicators, i.e. food mileage or carbon footprints, is normally perceived useful.

5 LESSONS LEARNED IN FIELD TRIALS

The view of CHILL-ON partners, their experiences in field trials and the lessons learned were obtained during round table discussions at the final CHILL-ON meeting in November 2010.

WP1 QMRA/SLP MODELS	Field trials in the project were valuable for the researchers to find out how the technologies operated in real time. Further research in collaboration with companies is needed, where the systems would be implemented for a longer period (i.e. one year) to verify and develop the QMRA/SLP models further and to adapt and validate the technologies (ICT hardware & software, chilling and packaging concepts, qPCR protocols, etc.) to meet the industry requirements.
WP2: QPCR TEST KITS	It was a challenge in the field trials to involve external testing laboratories, since they were not in all cases experts in the methods that were applied to provide verification of the performance of the qPCR kits. A very important aspect was to develop detailed protocols for the testing laboratories and conduct training for the staff.
WP3: CHILLING AND PACKAGING	Chilling optimisation could not be achieved in the field trials because in the trials, the project had to adapt to the current practices in the companies. However, the application of the models proved very useful to detect if changes in the handling of products or procedures in the companies had been made. For example, if the actual shelf life exceeded, or was shorter, than the expected shelflife when compared to the earlier mapping trials.
WP4: ICT HARDWARE AND SOFTWARE	A lesson learned was "Never to trust people when they say they are operating under certain conditions. In the field trials, this never was the case". It was invaluable for the technology developers to meet actors in the chain face to face in the stakeholder meetings. This should have been done much sooner in the project according to partners' opinions, and in many cases it was too late to take up discussions on modifications of the systems to adapt to the needs of the industry. Teamwork on the scene was the key to the success of the field trials and the detailed planning procedures. A very important factor is the ability to be able to collaborate and interact with the employees of the companies. The ideal situation would be to have the same industrial companies throughout the project. This would have ensured incremental, stepwise improvements throughout the project.
CHILE	Results on the real time traceability solution in the project are promising. However, it proved difficult to plan the work with companies in Chile to meet the expectations of the project. Despite this, the collaboration in the project was useful and valuable results on shelflife studies and models were obtained for the company in Chile.
CHINA	Preparation work carried out in China for the CHILL-ON project stimulated research activities related to models, dynamic temperature monitoring, traceability and logistic and cold chain management. A successful workshop was held in China with sixty people attending, both from companies and research communities.
BRAZIL	Poultry products are only transported frozen from Brazil to Europe, and therefore, this supply chain was not applicable for testing the developed CHILL-ON microbial models, since they were only

developed for chilled poultry. Two companies, Seara and Minuano, were working in the project, but other industries involved had different aims that were not easily compromised to the project´s aims. However, workshops were offered to the industry and TTI Ice will be tested on poultry products being transported to Europe. It was noted that the industry was curious to follow up on the project's results, and the learning process and experience gained by working with the industry was well appreciated, as well as new local collaborations that were formed.

Validation of the developed technologies in the field trials has given valuable guidance to further adapt the technologies, but some of the technologies still need further research to be viable on the market. There is a risk of failure to get a clear message to the market on the meaning, purpose and advantages of the CHILL-ON technologies.

⇒ Demonstrate the status and readiness of the CHILL-ON technologies for the industry by creating references from the field trials.

⇒ Clear messages on advantages, limitations, measurement accuracy and benchmarking of the CHILL-ON technologies against other technologies have to be stated.

⇒ Demonstrate the ability of the CHILL-ON technologies to provide verifications of performance that are comparable to conventional reference methods used in the industry and fulfill requirements of legislations and commercial standards. Although regulations were mentioned most often in stakeholder surveys as the key driver for implementing an electronically based information system and innovative technologies, industry driven initiatives to improve competitiveness of companies are likely to be the motivation for implementation of the CHILL-ON technologies in the food supply chain.

6 MARKET POTENTIAL OF CHILL-ON TECHNOLOGIES

The TRACECHILL system, which includes all of the CHILL-ON developments, is a solution with a holistic focus on the entire value chain to ensure products' traceability, safety and quality management by monitoring temperature, tracking GPS location and providing shelf life predictions in real time. Alerts in case of microbial contamination or abusive temperature scenarios, which may limit the shelflife or pose risk to consumers, can be effectively reported in the system. Throughout the value and distribution chain, there are several possibilities to improve present situations in supply chain management. This concerns both the cost side as well as the revenue side and can, in some cases, turn CHILL-ON into a kind of marketing tool, according to a partner from the fish sector. However, since neither the CHILL-ON partners nor the stakeholders appear to be ready for the implementation of the overall CHILL-ON concept, the main results from CHILL-ON will most likely be exploited as stand-alone solutions.

6.1 RECOMMENDATIONS

The real challenge for the technology developers in the CHILL-ON project will be to implement their solutions in collaboration with supply chain actors and demonstrate the enhanced performance of the supply chain and the functional qualities of their technologies. Clear messages should be given on how the technologies can be adopted to offer a positive return on investment in terms of increased benefits.

6.1.1 TRANSPARENCY IN THE SUPPLY CHAIN AND TEMPERATURE MONITORING

Low temperature in the chilled chain is the key to safe food supply of good quality. Temperature is interoperable in the entire supply chain. Therefore, the verification of temperature conditions of products by real time monitoring and giving relevant actors in the supply chains access to the data have the potential to enhance transparency in the chain. According to stakeholders, mistrust can occur between actors in all steps in the supply chain. A valid verification of temperature conditions was considered an asset for stakeholders, but mainly to confirm if a break in the chain had occurred.

⇒ *Provide solutions for real-time monitoring and valid verifications of temperature scenarios of products to enhance transparency and trust in the supply chain*.

6.1.2 SUPPLY CHAIN MANAGEMENT SYSTEMS

Electronic information and traceability systems: Opportunities were identified in relation to innovative solutions for the supply chain and added value features, such as providing detailed information on products' conditions, handling, origin, shelflife, risks for consumers and environmental attributes. Costs regarding installation and operation of the systems were considered the main barrier according to stakeholders.

⇒ *Alliances and collaborations in the chain are recommended to implement systems. Stronger ties should be established between actors in the chain as well as with clients/consumers*

⇒ *Sharing of the cost of implementation*

6.1.3 QUALITY AND QUALITY ASSURANCE

Stakeholders focus groups and surveys confirmed that shelflife and quality of products are the key attributes of economic and consumer drivers for implementing the CHILL-ON solutions. Cost/benefit ratios and improved supply chain management were also stated as important drivers.

Expectations of companies regarding efficient quality and cost management, waste reduction and support to operational management system can be met by:

⇒ *Verification of products temperature*

⇒ *Translation of temperature information into relevant quality parameters*

⇒ *Shelflife prediction in terms of days of marketability of products or remaining shelflife*

⇒ *Smart labels/TTIs as quality indicators- adapted to selected products*

⇒ *Rapid detection of spoilage bacteria and hygienic indicators by qPCR - validated against conventional methods*

⇒ *Decision support system adapted to selected chains, with information on temperature scenarios, relevant limits for temperature of products, microbial counts and alert criteria.*

6.1.4 FOOD SAFETY

⇒ *Rapid detection of pathogens (PCR test kits)*

⇒ *Develop a QMRA model in collaboration with companies to support their HACCP system*

6.1.5 VALUE ADDED MARKETING TOOL

Opportunities were identified regarding innovative solutions for the supply chain, for example, to support decisions regarding transportation modes. Derived values, like calculation of carbon footprint, to meet demands on environmental issues would enhance the competitive advantage of companies.

⇒ *Providing information on environmental indicators, i.e. food mileage or carbon footprints, as an added value feature would enhance the competitiveness of the CHILL-ON technologies.*

⇒ *Distribution and logistics implications for real time monitoring systems*

⇒ *Implication for trademarks and production agreements under clients' brands.*

⇒ *Ability to cater for niche marketing*

6.1.6 TRAINING

The experience gained in the stakeholder meetings revealed that there is lack of knowledge within the food supply chains on the potential of CHILL-ON technologies and more communication and training efforts are needed on the functionality and benefits of the CHILL-ON technologies to enhance their marketability.

⇒ *Enhance the knowledge and understanding of the potentialities of the CHILL-ON technologies within the industries by dissemination*

⇒ *Introduce the CHILL-ON technologies to all relevant stakeholders, including inspection agencies and insurance companies, and keep in mind that retailers are likely to push for innovative technologies if benefits are clear*

⇒ *Training on how CHILL-ON technologies can improve management in the entire supply chain and enhance transparency*

⇒ *Training on potential marketable stand-alone or combined solutions to enhance awareness in the industry (TTIs, RF-TTI, PCR test kits for bacteria, T-sensors, MMU, TRACECHILL software - T&T, GIS, OLMC, DSS)*

⇒ *Scientific knowledge on optimized handling, chilling and packaging concepts can be exploited for training in the industry, and to motivate innovation in processes and products to help companies in developing new marketing opportunities*

6.1.7 DISSEMINATION OF CHILL-ON TECHNICAL SOLUTIONS AND RESEARCH

⇒ *All scientific publications, reports, articles and training material will be available on the CHILL-ON website to enhance the dissemination and facilitate the exploitation of the project's results after the end of the project. The website will be maintained by TTZ for five years after the project's end (www.chill-on.com).*

7 ABBREVIATIONS

DSS	Decision Support System
DAM	Data Acquisition Management
HACCP	Hazard Analysis and Critical Control Points
MMU	Mobile Management Unit
SMU	Stationary Management Unit
qPCR	Quantitative Polymerase Chain Reaction
QMRA	Quantitative Microbial Risk Assessment
SCM	Supply Chain Management
SLP	Shelf Life Predictor
TTI	Time Temperature Indicator
OLMC	On Line Monitoring Client
Rf-ID	Radio Frequency Identifier
GIS	Geographic Information Service

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APPENDIX I. GUIDELINES FOR SWOT ANALYSIS:

CHILL-ON refers to: CHILL-ON project´s results and developed technologies

Strengths - What are the outstanding achievements of the CHILL-ON?

Some questions to help you get started: What makes CHILL-ONstand out from your competitors? What advantages does CHILL-ONhave over other businesses? What unique resources does CHILL-ON have?

Weaknesses - List the areas that are a struggle for CHILL-ON.

Some questions to help you get started: What would customers complain about? Where is the weakness in CHILL-ONtechnology? How is CHILL-ON weaknesses compared with other projects? What can be improved?

Opportunities –External opportunities, beyond CHILL-ONcontrol, which could give CHILL-ONfuture opportunities.

Some questions to help you get started: What opportunities exist in the environment? What trends do you see in the industry? Where do you see CHILL-ONas a whole enter the market? What effect will supply chain politics or legislation have? What will be the market development?

Threats - External threats, beyond CHILL-ON´s control, which could place the mission or operation at risk.

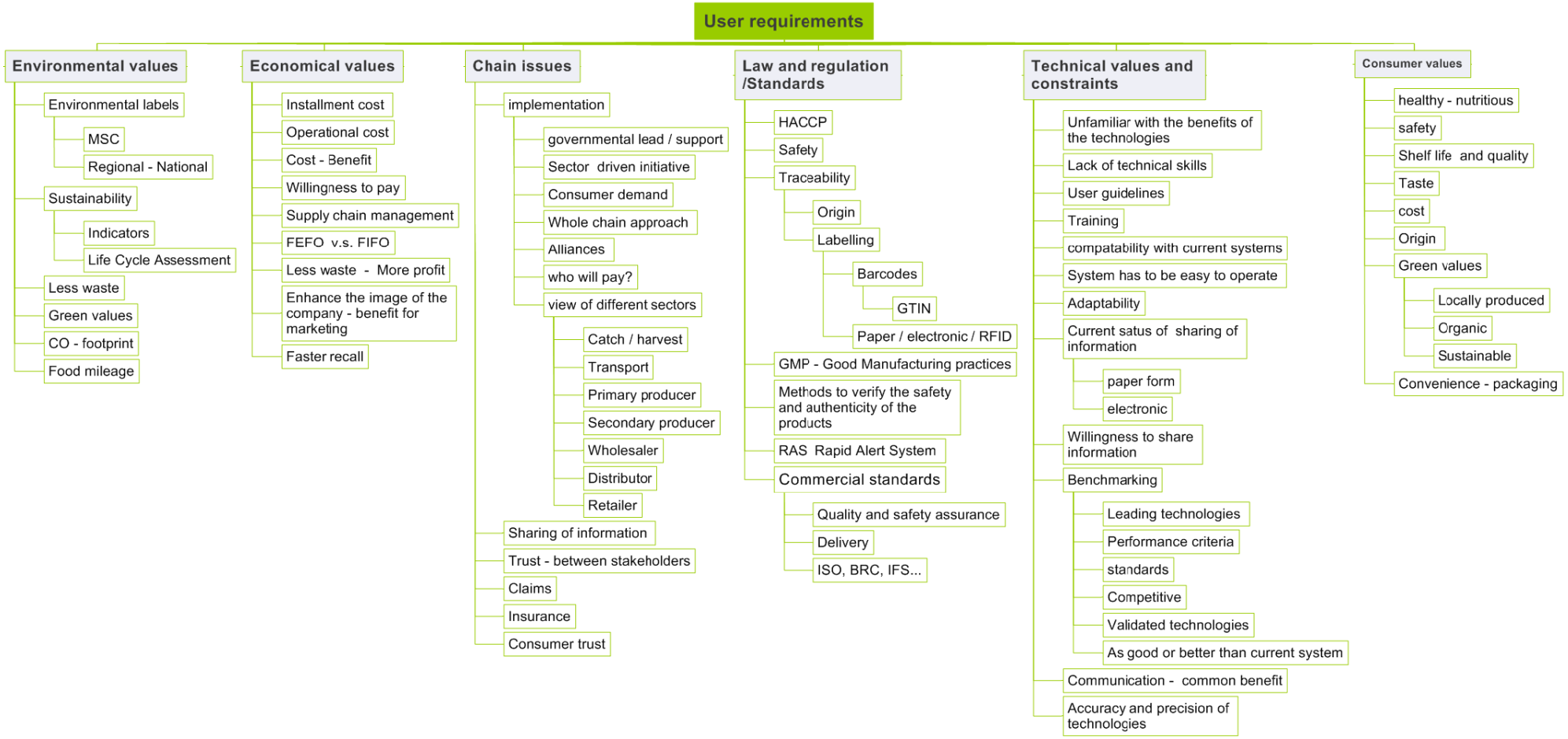
Some questions to help you get started: What obstacles do CHILL-ONface? What is the market doing that we are not doing? What challenges will there be to get CHILL-ONto the market?

Please use as much space as you need – not only keywords.

Partner:

Internal	
Strengths	**Weaknesses**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.
External	
Opportunities	**Threats**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

APPENDIX II. MAPPING OF USER REQUIREMENTS AND CHILL-ON CONCEPTS



CHILL-ON

Transparency of the supply chain enhanced by real time temperature monitoring

CHILL-ON

Temperature is interoperable in the whole chain

Chill-on concepts

- Overall Concept: Enhance quality, safety and traceability of food supply for consumers
- Rapid test kits for bacteria
  – verify the occurence or non occurence of pathogens (PCR)
  - measure microbial counts in products to verify the hygienic status (qPCR)
  - spoilage bacteria counts in products to verify the quality and shelflife (qPCR)
- Optimized chilling - guidelines
  – ensure safe products with extended shelf life of good sensory quality
- Electronic Tracebility - TRACECHILL
- Time and temperature history - verification of temperature conditions in the chain
  – assessment of microbial risk
  – calculation of remaining shelf life
  – alert if temperature is out of range - verification by smart label (TTI)
- Optimized packcaging
  – innovative new packaging concepts
- Operational Concept: Accessible information on temperature and location in real time
- Applied Concepts:
  - enhance consumer trust
  – supply chain efficiency
  – lower the cost of recalls,
  – minimize perishable waste,
  – enhance sustainability of products

Low temperature in the whole chain is the key to safe food supply of good quality

Chill-on technologies

- Temperature and location
  - T-sensors
  - GPS
  - MMU / SMU
- Tracechill server OLMC - SCM
  - GIS- geographic information system
  - Decision Support System for Electronic Supply Chain Management
- Quality and Safety predicted by models and smart labels.
  - QMRA- Quantitative Microbial Risk assessment
  - SLP- Shelf life prediction model
  - Time temperature indicators TTI´s
  - Verification by rapid tests
    - Rapid test -qPCR
    - Type of bacteria
      Spoilage
      Pathogens
      Hygienic
- Optimized chilling and packaging
  - Guidelines and recommendations