EFITA WCCA CIGR
2013 Conference
June 23-27, 2013
TORINO, ITALY
Sustainable Agriculture through ICT innovation

Assisting SMEs to integrate digital Food Supply Chains

Gil Gonçalves (gil.goncalves@inovamais.pt) [1,2] Catarina Azevedo [1], César Toscano [3], Gaelle Chéruy Pottiau [4], Bruno Prépin [4]
[1] Inovamais SA, Rua Dr. Afonso Cordeiro 567, 4450-309 Matosinhos, Portugal
[2] University of Porto, Faculty of Engineering, [3] INESC-Porto, [4] Agro EDI Europe

ABSTRACT

This paper presents the eFoodChain project, its objectives and main achievements so far. The overall goal of the eFoodChain project is to contribute to the improvement in the competitiveness and efficiency of the agro food industry in Europe by stimulating an innovative and seamless use of ICT along its value chain. SMEs, that represent more than 99% of companies and generate approximately half of the industry turnover, are the focus of this action, as the objective is to facilitate their participation in the global digital food value network and enable them to become international business partners.

We present the first results of the project, starting with an analysis of the current European landscape in electronic message exchange in the agro food value chain, the eFoodChain proposed approach to improve its efficiency and promote the inclusion of SMEs, and discuss the pilot scenarios that will be implemented to demonstrate this approach.

Keywords: EDI Electronic data interchange, Agro-food industry, Reference process models, ICT platform, Europe

1. INTRODUCTION

The European agro-food industry plays a substantial role in the European economy. It is essential for economic, social and environmental welfare as well as for the health of European citizens. Moreover, it is a significant contributor to employment and growth. A special feature concerning this industry is the importance of SMEs, as they represent more than 99% of companies, and generate almost a half of the industry turnover. SMEs are really major players of the agro food industry in Europe that need to be taken into consideration.

Despite significant developments and increased usage of ICT (Information and Communication Technologies), there is much inefficiency today in the value chain management (or supply chain management) of almost every sector of the economy. Many companies are using incompatible eBusiness processes, ICT systems and infrastructures and data exchange models. The validity and acceptance of data models underpinning business transactions (e-Catalogues, e-Ordering, e-Invoicing, etc.) still follows national rules, making cross-border transactions difficult. Moreover, security, authenticity and integrity considerations lead to an operational risk and thus to a lack of trust. This results in a fragmented technological outlook, with a multiplicity of incompatible business standards, data models and ICT solutions and with very low interoperability levels, especially across borders.

The eFoodChain project (www.efoodchain.eu), funded by the European Commission, aims to be an important step towards the promotion of innovation and ICT in the food supply chain, with a view to support digital connection of SMEs into the value chain. The overall goal of this initiative, run by an international consortium, is to stimulate the use of ICT and facilitate paperless B2B (Business-to-Business) data exchanges along the agro food value chain. In particular, SMEs are at the centre of interest of this action, as the objective is to facilitate the participation of SMEs in global digital food value network and enable them to become international business partners.

This paper is organised as follows. Section 2 presents the motivation and state of the art in the adoption of ICT in support of B2B transactions, notably the European landscape in electronic data exchange in the agro food industry. In section 3 we introduce the eFoodChain interoperability framework, focusing on its reference model (general and specific for each of the target sectors) and electronic messages that support this model. Section 4 contains an initial description of a set of pilot scenarios that will be used to validate and demonstrate the eFoodChain interoperability framework. Conclusions of the achievements so far and future work are presented in section 5.

2. MOTIVATION AND STATE-OF-THE-ART

The agro food sector is not only the biggest manufacturing industry in Europe with a turnover of 929 billion Euros, but also the leading manufacturing employer with more than 4 million direct jobs (Eurostat, 2010). A special feature concerning this industry is the importance of SMEs, as they represent more than 99% of companies, and generate almost half of the industry turnover. Given this high representation of SMEs in the industry, also the importance of general food retail shall be noted. In fact, food retail in Europe has become highly concentrated in the last decades: 15 big retailers share about 50% of the market (Veraart Research Group, 2012).

Consequently, the relationships along the value chain are influenced by this concentration, and the power distribution between all actors in the value chain isn't equal. As argued by Grievink (Grievink, 2002), a high number of producers and consumers have to face a low number of retailers who keep power on upstream and downstream.

To face this low number of actors in the middle of the value chain, producers are more and more organising themselves into cooperatives. This organization of the producers, into some sort of producer organisation, allows them to get more power in negotiations in the supplier-farmer of farmer-processor relationship. However, there is still a huge unbalance in the negotiation power in the supply chain, which also affects the decision of adoption of new solutions or technologies in the supply chain. Concerning the decision to adopt new solutions and technologies in the supply chain, this is concentrated downstream in the chain.

Even though direct sales and short supply chains are developing, meaning that B2C (Business to Customer) relationships are already present in the supply chain, the most common type of business in the agro food sector is still B2B (Business to Business). This is in relation with the fragmentation of the market, with much inefficiency in the supply chain, but also with customers' infidelity with the suppliers and the abrupt variation that can happen with the value of products (Bejjani, 2000).

Another important relationship that has to be accounted for, in what concerns the information flow in the supply chain, is the communication flow with the government or authorities. B2G (Business to Government) and G2G (Government to Government) in cross border trade is also a very important aspect that has to be considered. Currently multiple requests of information are made to the different players: from different bodies, in different formats and with different purposes.

In order to estimate the current level and the trends in the adoption of ICT solutions underpinning B2B transactions in the food supply chain several analysis have been conducted (eFoodChain Consortium, 2012), covering the whole supply chain (but limited to the fresh fruits and vegetables, dairy products and cereals sectors), from producer to retailer, in ten European countries: Belgium, France, Germany, Greece, Italy, Netherlands, Poland, Portugal, Spain and the United Kingdom. The analysis involved reaching to more than 4000 organisations, with more than 350 responses to an on-line survey, and individual interviews with 44 agro-food organisations and 26 ICT solution providers.

The results highlight a real heterogeneity of the ICT adoption and use amongst sectors. Also, the use and integration of B2B standards by ERP providers is limited. The cereals industry as well as the fresh fruits

and vegetables industry seems to be well equipped, but the dairy industry appears less involved in the implementation of ICT solutions. Moreover, a huge gap exists along the value chain.

This study showed that the most common electronic messages used are financial messages such as orders, order responses and invoices. The predominance of EDI (Electronic Data Interchange) through UN/EDIFACT standards (the United Nations rules for Electronic Data Interchange for Administration, Commerce and Transport) is still important to the exchange of business messages, and an important part of companies using ICT solutions prefer this technology for order or invoice messages (Figure 1). The exchange of electronic business messages isn't integrated with other business information systems in 40% of companies. However, almost half of them have a system integrated with their ERP (Enterprise Resource Planning). Still according to this study, few companies automatically exchange traceability messages (Figure 1), and few companies use machine-readable labels. Yet, new legislations regarding traceability might influence this, as many companies plan to develop traceability systems.

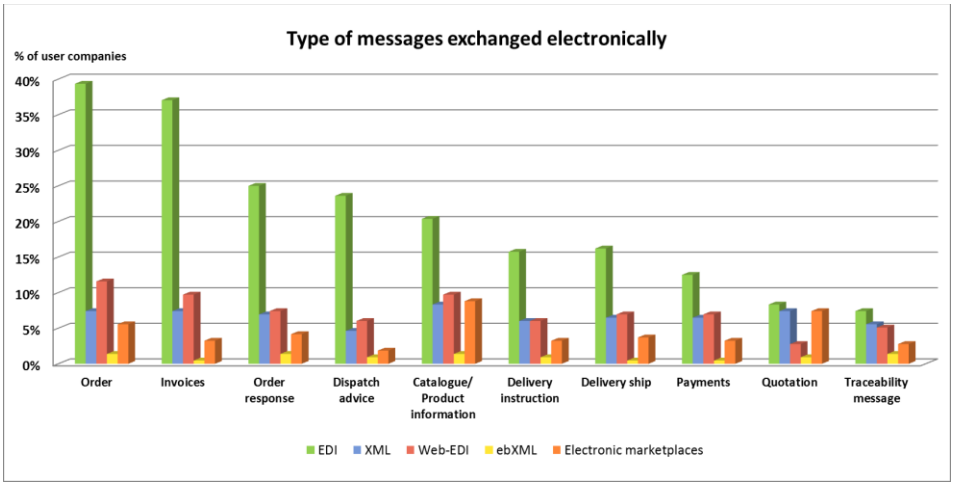

Figure 1: Types of messages and technologies used for the automatic exchange of data

The use of the Internet for business transactions is still low. More than a third of the surveyed companies never use their partners' web portals, and half of them use less than 4 web portals regularly.

3. EFOODCHAIN REFERENCE FRAMEWORK

eFoodChain aims to develop and demonstrate an overall sectoral collaborative reference framework setting the principles and rules for interoperability among business processes and data exchange models to allow for seamless, paperless information and data flows underpinning B2B transactions along the food supply chain (specifically addressing the cereals, fresh fruits and vegetables, and dairy products supply chains) in order to promote interoperability at cross-border level all over Europe.

The development of the eFoodChain Framework is being carried out in an iterative way, with several versions of this specification being released and tested during the project. The Framework will be demonstrated and validated through the setup, monitoring and evaluation of sectoral and cross-border pilot-prototypes, with the objective to demonstrate the interoperability of business processes and information flows and show how different systems and infrastructures can interoperate. Gathered feedback, observations, remarks and best practices from the pilots will provide inputs for further improvement of the Framework.

The eFoodChain Framework is an open architecture, excluding any proprietary elements and aims to be applied throughout European food supply chains without any IPR restriction. With this in mind the

application of the "European Union Public Licence" (EUPL) for the overall framework is being considered, in order to guarantee a broad based take-up of the results.

Following a layered approach, the eFoodChain Framework (see Figure 1) is organized in four areas:

- Business Scenarios – The business application layer of the Framework, which defines the set of business scenarios that drive the remaining parts of the Framework, according to the scenarios that emerged from the market analysis done initially (eFoodChain Consortium, 2012): eInvoicing; Food safety and quality and sustainable production and products.
- Business Processes –This second layer of the Framework describes the business processes that support the realization of the business scenarios defined in the first layer. This is complemented by the identification of location and product identification methods, and product classification schemes. Considering the eInvoicing business scenario an analysis of current legislation is made in order to identify the key requirements that an ICT implementation should met.
- Messages and Data Models – Within this layer, the eFoodChain Framework describes the set of electronic messages and correspondent data models that enable and support the realization of the eFoodChain business processes.
- ICT architecture and middleware – This last element of the eFoodChain Framework addresses ICT related aspects concerning the way electronic messages are securely transported from business entity to business entity along the food supply chain and identifies major services and interfaces for that purpose.

Figure 1 – Overview of the eFoodChain Framework

In the second layer, for each target sector (Fresh Fruits and Vegetables, Cereals and Dairy), a Reference Process Model is defined, using a transaction and network oriented approach, where a transaction is defined as an exchange of information, electronic or otherwise, between two business entities in the supply chain. This is followed by a definition of the methods for achieving product classification and identification along the food supply chain. Figure 3 overviews the reference model for the "Cereals" sector.

Each of these processes is detailed and their transactions are identified and mapped into electronic business documents (electronic messages) and data models that are available to support the business

scenarios, reference process models and identification elements previously defined. Some of these messages are listed in the next table. Most of the XML-based messages selected by the Framework are UN/CEFACT standards, and for such message, typical interchange scenarios are identified and the correspondent conceptual data model is presented. UN/EDIFACT messages are also proposed by the Framework so as to cover the processes where such messages (and/or variants of them) are currently used.

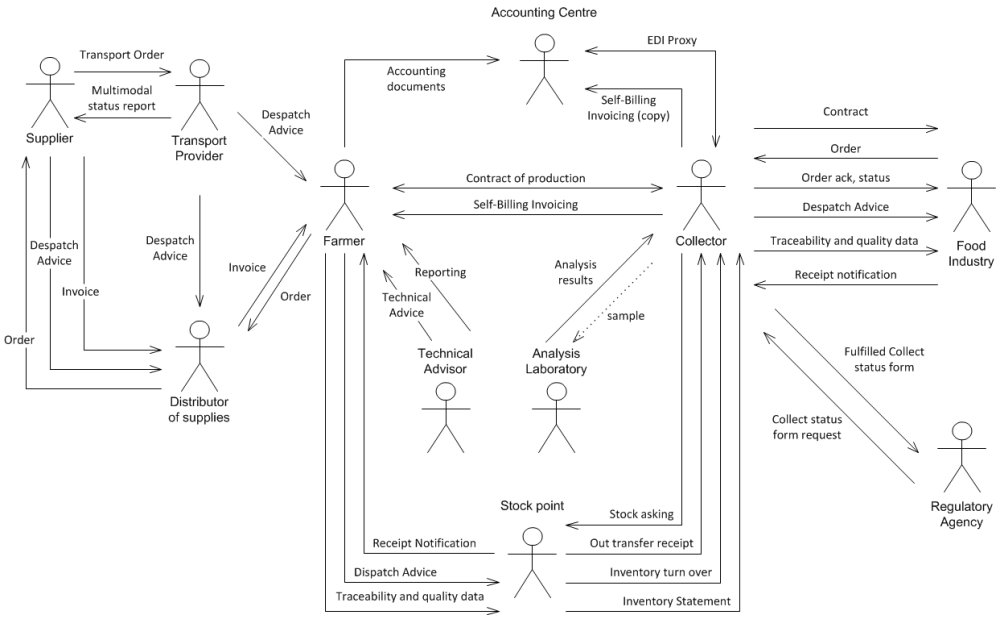

Figure 3 – Reference process model (cereals)

Table 1. eMessages and data models (sample)

eMessage	Description
eDAPLOS (UN/CEFACT)	Crop data sheet message to support traceability information.
Cultivation Message (Frug I Com, GS1)	Crop data sheet message to support traceability information in the Fresh Fruits and Vegetables sector.
Agronomical Observation Report (UN/CEFACT)	Message to support the reporting on crop observations about crop pests and diseases.
eLabs, e-Laboratory Observation Report (UN/CEFACT)	Message allowing a laboratory to report measurements and observations performed in a laboratory.
eCert, XML for Sanitary & Phytosanitary Certificates (UN/CEFACT)	Message allowing an Export Regulator to issue an Export Certificate to an Import Regulator stating the sanitary & phytosanitary conditions of a product.

Taking into consideration major trends in the ICT sector, a Service Oriented Architecture (OASIS, 2006) is proposed in the Framework's bottom layer. The aim is for the Framework to specify the ICT support in the form of loosely coupled, coarse-grained, and autonomous components called services (Rotem-Gal-Oz, 2012). Each service exposes processes and behaviour through contracts, which are composed of messages at discoverable addresses (endpoints). The behaviour of the service is governed by policies that are external to the service itself. Contracts and messages are used by external components called service consumers.

Currently, one service, named Messaging Service, is defined for supporting the B2B transactions defined in reference process models by exploiting the selected electronic messages. The service is to be provided to any business entity in the supply chain (farmer, producer organization, technical partner, etc.) through which a business document is encapsulated within the Standard Business Document Header (SBDH) from UN/CEFACT and sent over the Internet to the business entity with whom he has a business relationship. The service aims to support point to point and hub-based information flow between partners in a given food supply chain in support of B2B transactions generally related with product and financial flows in the supply chain. Two Application Program Interfaces (API) are defined to support the electronic data interchange: AS2 (Applicability Statement) over HTTPS and SOAP (Simple Object Access Protocol) over HTTPS (a REST "Representational State Transfer" API may be defined in the future).

For the implementation of the Messaging Service, two software components are defined (see Figure 4): B2B Connector, a simple and modular software component providing electronic data transfer to the ICT infrastructure of a company and that can be deployed in two ways depending on the company's ICT strategy (own ICT infrastructure of the company or in a computing cloud); B2B Connector Supervisor, a software component to be managed by an ICT Service Provider with the responsibility to manage a set of B2B Connectors, i.e., to configure and monitor those B2B Connectors so as to assure they are properly setup according to the companys' needs and that they are operationally running as expected in the day to day B2B transactions.

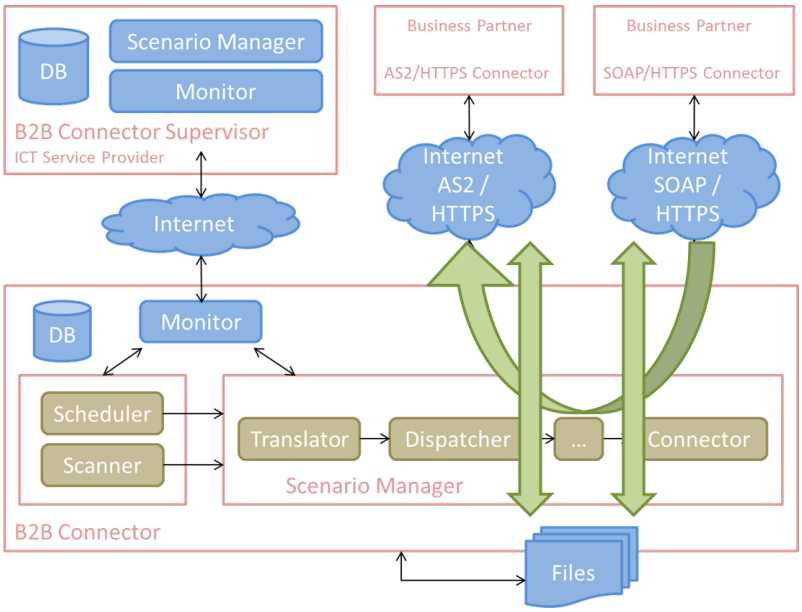

Figure 4 – eFoodChain ICT architecture

The main concept linking the two above components is the "Scenario". A Scenario defines the internal workflow of a B2B Connector. A task in the workflow can be a request to a translator function, to a log function, to a routing function, to the transfer of the message to another B2B Connector, etc. Scenarios are created and managed by the B2B Connector Supervisor and uploaded to the correspondent B2B Connector in order to properly configure it and adapt the connector to the needs of the organisation.

4. INNOVATORS AND EARLY ADOPTERS SCHEME

The Innovators and Early Adopters Scheme aims to validate the eFoodChain Framework, through the setup, monitoring and evaluation of sectoral and cross-border pilot-prototypes. Various agro-food stakeholders, participating in different pilots, demonstrate how the solution proposed by the project can

promote the integration of SMEs along the value chain. Feedback obtained along the process will contribute to further improvement and fine-tuning of the Framework. The Scheme is divided into two pilot phases: the first phase involves only few participants locally to develop the solution first and then developments of these pilot projects will bring us to the second phase which aims to extend pilot scope to many countries and to involve more participants.

From the state-of-the-art results, it was possible to conclude that the priorities for intervention are mainly in the upstream area. Opportunities to improve the supply chain, through more and better integration of SMEs in digital transactions, were identified as being mostly in the areas of e-invoicing, food safety and quality, product and production certification, exchange of laboratory tests and quality results, and sustainable production and products.

The e-documents project is an example of pilot prototypes that is part of Phase I, and is focused on implementing dematerialization of all exchanged documents between cooperatives, their farmers and accounting centres for farmers who have one. This approach aims to offer farmers a complete service to dematerialize all the documents they receive from their cooperative.

The e-documents pilot is at this stage implemented in France and managed by Agro EDI Europe (http://www.agroedieurope.fr/). Invoice is the most strategic document because of associated tax regulations and controls. Member States transposed the European directive on invoicing and e-invoicing processes into national laws, with specific ICT requirements for each of them. Due to these specifications, this project has a high potential for its wider transferability and multiplication in many other European countries. Figure 5 depicts the expected outcome of the implementation of the eFoodChain Framework in this specific project: how the documentary processes run today and how the system will look like and after the e-documents pilot project is completed.

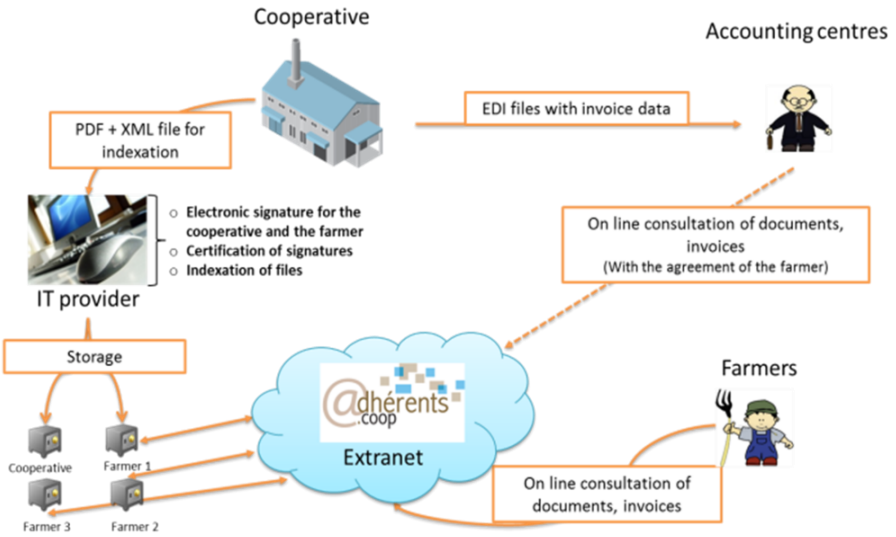

Figure 5 – e-documents pilot

The partners involved in this French pilot project include Adhérents.coop (an union of 40 cooperatives who provides extranet system for farmers who are members of a cooperative), five cooperatives (among which four are members of Adhérents.coop and one who has its own extranet system)[1], and an ICT

[1] These cooperatives represent around 23.000 French farmers; during the pilot phase, between one and ten farmers per cooperative are involved.

provider expert in dematerialization systems. This pilot project started in April 2013 and is running until the end of August 2013, its evaluation finalizing in October 2013.

5. CONCLUSION AND FUTURE WORK

The project has developed two draft versions of the eFoodChain Reference Framework. A reference process model was developed for each target sector, i.e. Fresh Fruits and Vegetables, Cereals and Dairy products. Business transactions are defined and available standard electronic messages are proposed to support the correspondent electronic data interchanges. A first ICT architectural element in the form of a service is specified for supporting B2B transactions.

Currently the project initiated the demonstration and validation stage of the eFoodChain Reference Framework - "Innovators and Early Adopters Scheme" – during which the pilot-prototype projects involving various agro-food actors are testing and exploiting the innovative potential of standardized digital data exchanges. The eFoodChain Innovators and Early Adopters Scheme is divided into two pilot phases: the first phase involves two pilot projects (currently running), while the second phase will start in summer 2013, extending the demonstration scope.

ACKNOWLEDGMENTS

The project is being developed with support of the Directorate-General for Enterprise and Industry of the European Commission and is being implemented by a consortium composed of: AGRO EDI EUROPE, INOVA+, INESC Porto, Dutch Produce Association, Assembly of the European Regions producing Fruit, Vegetables and Plants, Polish Grain and Feed Chamber, Food-Processing Initiative and SisTrade.

We would also thank for the collaboration of all the organisations participating in the eFoodChain Innovators and Early Adopters Scheme, for their valuable feedback and support in improving the Reference Framework.

REFERENCES

Bejjani G. 2000. E-commerce: the net effect of agribusiness, Capital Investment and market makers. Morgan Stanley & Dean Witter. USA.

eFoodChain Consortium. 2012. Market Analysis Report v2.0. http://www.efoodchain.eu/.

Eurostat. 2010. DG Agriculture Statistical and Economic Information Report, [online] http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home (retrieved 05 2012).

Grievink, Jan-Willem, Lia Josten and Conny Valk. 2002. State of the art in Food - The changing face of the worldwide food industry. Reed Elsevier.

Lehmann, Richard J., Reiche, Robert and Schiefer, Gerhard. 2012. Future internet and the agri-food sector: State-of-the-art in literature and research. Computers and Electronics in Agriculture 89.

OASIS. 2006. Reference Model for Service Oriented Architecture 1.0. http://docs.oasis-open.org/soa-rm/soa-ra/v1.0/cs01/soa-ra-v1.0-cs01.html (retrieved 05 2013).

Rotem-Gal-Oz, Arnon. 2012. SOA Patterns. Manning Publications Co.

Veraart Research Group. 2012. Food retailers in Europe and worldwide. Retailers in Europe - European Retail Rankings, [online] http://www.retailindex.com/HomeSearch/RetailersinEuropedatabasebysectorEnglish/FoodRetailersinEuropeandworldwide.aspx (retrieved 05 2012)

Wolfert, J., Verdouw, C.N., Verloop, C.M. and Beulens, A.J.M. 2010. Organizing information integration in agri-food - A method based on a service-oriented architecture and living lab approach. Computers and Electronics in Agriculture 70.
