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The Global Track&Trace System for food: General framework and functioning principles

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ABSTRACT

This paper describes the Global Track and Trace System (GTTS) developed for supporting the management of food traceability along the food supply chain, from the primary producer to the final consumer. The main goal of GTTS is to support the different users involved in a food supply chain and assist in the process of traceability management. The informative system has been developed taking into account the different features of a food supply chain. A general framework has been generated for supporting future evolutions and customizations. Different steps, which involve the phases of supply chain analysis, supply chain modelling, data analysis and data modelling, are at the base of the methodological approach followed during the phase of system design and development. The solution adopted for the information management is generally applicable, which means that it meets the requirements of different types of food industries. The model can be applied in real-life situations that might benefits from the traceability solution.

1. Introduction

Nowadays, food traceability represents one of the main concerns for public authorities and industries. In particular, traceability has become a critical part of the agro-food industry. The aim of the agro-food traceability is to allow the full monitoring of a product in the supply chain and to trace the history of a good from the producer to the consumer ("from farm to fork"). In these terms, it is a preventive instrument of quality and safety management. In addition, the implementation of an appropriate traceability system, which is able to guarantee the continuous monitoring of the flow of products and information and capable of facilitating the process of certification, is strategically essential to achieve continuous quality improvements.

Traceability has gained considerable importance in the food sector, particularly following a series of food crisis and safety incidents during which traceability systems have been shown to be weak or absent (Food Standards Agency, 2002). In the last decade, several institutions have promoted the introduction of control systems able to effectively trace not conforming goods and to identify the factors of risks which compromise food quality and hygiene and create dangerous conditions for human health. Important regulations have been introduced to define the general principles of food quality and safety at the national and European level (European Commission, 2002). Food traceability regulations in North America are being implemented as a result of the Food Safety Modernization Act (United States, 2011) in the United States of America and Safe Food for Canadian Act (SFCA, 2012) in Canada. In particular, in the United States of America the fundamental rules concerning food traceability have been introduced by the Bioterrorism Act (United States, 2002) that came into force after the event of 11 September 2001. Also Japan and other developed countries have enacted retroactive food safety-related regulations that actively promote raising the food traceability system and gradually become a new trade barrier. Companies all around the world (UE, Japan, USA, Australia, etc.) deal with different implementation of responsibility and liability regulations of products (Mirabelli et al., 2012a). Nevertheless, the food sector is continuously exposed to risks and dangers due to the incapacity to assure the correct link between the flow of products and the flow of information. In order to reduce the exposure to such kind of risks and food safety problems, the widespread adoption of efficient traceability systems is desirable.

The main aim of the work is to present the methodological approach used in the process of design and development of a traceability system for food products and to prove how the general framework can be easily adapted to the different food supply chain. The system itself can assist users in case of food outbreak diseases and in case of recall procedures through the identification

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of the most relevant information for the problem resolution. By implementing the developed Global Track&Trace System (GTTS) at a high level of the supply chain, the competitiveness, and the effectiveness of the supply chain itself can be improved. The proposed tracking system allows to record data on the products handled and data on the processes executed, such as the instant of starting and ending of working and the non-conformity of a process. These data allow calculating different performance indicators (Key Performance Indicators, or KPIs), such as the mean and the variance of an activity or process or the average percentage of non-conformity of a product. The monitoring of processes using the KPI permits to check the organization's productivity and overall efficiency of the company, while collected data in can be used to simulate changes in the organizational and working configurations to improve the performance of the system. In addition, data about processes can be used to identify critical issues, evaluate the performance of actors involved in the system or to efficiently manage inventories. All this is obtained with a view to continuous improvement and continuous optimization.

The solution adopted for the information management is generally applicable, which means that it meets the requirements of different types of food industries. The model can be applied in real-life situations that might benefits from the traceability solution.

The general framework is obtained through the design and definition of a Global Track and Trace Informative System. The development of the informative system requires the modelling of business processes and associated data results. In the proposed framework the supply chain has been modelled according to the BPMN standard. BPMN allows reconstructing patterns of process or the Business Process Diagram (BPD) by means of graphs or networks of objects. From the modelling and the analysis of product processes in the chain, authors want to be aware of data to be recorded. As a consequence, a general data model is proposed. The data model is enough flexible and open to join future changes.

The proposed framework can be a strategic approach for information and process management, also at the farm level. The term farm is used to refer to the various processes involved in the agricultural production. In fact, depending on the raw materials produced, the agricultural processes can be distinguished into crop cultivation processes, aquaculture, livestock or poultry production processes. The model permits the supply chain optimization and the food quality management. The system itself can be a valuable tool for assuring customers and promoting the liability of the production process, along with the compliance with the regulatory standards for defining quality and safety requirements.

The paper is organized as follows. In Section 2, fundamentals of food traceability are introduced. In Section 3 a brief overview of the state of the art about the traceability frameworks presented in literature is proposed. Section 4 describes the research questions; the main issue related with food traceability are discusses and strengths, weakness, opportunities and threats related with the introduction of effective traceability systems are presented. In Section 5 the Global Track and Trace general framework is described in its entirety: in the first subsection the methodological approach followed for the design and development of the general framework is introduced, with a particular focus on the general architecture of the system itself; then the functioning principles of the system are explained to prove how the system can be easily adapted to different types of food supply chain. Finally, results and conclusions are discussed in Section 6.

2. Fundamentals of food traceability

This section provides a brief overview on the main concepts related with food traceability, focusing on benefits and disadvantages that can be obtained through the implementation of a traceability system.

2.1. Traceability definition

Several definitions of traceability have been proposed from organizations, legislations and research literature. The International Standard Organization defines traceability as "*the ability to trace the history, application or location of an entity, by means of recorded identifications*" (UNI EN ISO 8402, 1994). The Codex Alimentarius Commission defines traceability as "*the ability to follow the movement of a food through specified stage(s) of production, processing and distribution. The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system*" (Codex Alimentarius Commission, 2006). In Europe, Regulation (EC) 178/2002 represents the main regulatory reference for the food legislation on food traceability and safety. It defines traceability as "*the ability to trace and follow food, feed, and ingredients through all stages of production, processing and distribution*" (European Commission, 2002).

In the last years, a series of new legislations has been introduced for laying down mandatory data to record for the traceability maintenance. Mandatory data includes lot number, product ID, product description, supplier ID, quantity, unit of measure, buyer ID (European Commission, 2002). Moreover, mandatory data are not sufficient for guaranteeing product's quality and safety. Additional data must be recorded for supporting in the identification of products origin. The concept of traceability, in fact, does not mean just record information about the origin of the product but record information about all the steps in which the product is employed throughout the supply chain. In these terms, traceability adds value to the overall quality management system by providing the communication linkage for identifying, verifying and isolating sources of noncompliance and to agree with standards and customer expectations.

The requirement for additional data to record is stressed, in literature, by Moe (1998) that defines traceability as "an ability by which one may track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales, or internally in one of the steps in the chain, for example the production step". The definition of the term emphasizes the importance of supporting mandatory data with the introduction of optional data about food ingredients, process parameters, products and services involved in the production process, along with logistic data and information about the transportation phase.

The maintenance of traceability is a complicated and expensive process, especially with regards to processed food. In case of processed foods, in fact, different lots of various raw materials are combined into several production batches typically distributed in various points of sale (Hu et al., 2009). Hence, data to record must include information on products and on processes that operate on products (such as transport, transformation or combination). Kim et al. (1995) state, in fact, that a traceability system must be able to track both products and activities operate on products. This goal can be reached through the implementation of an efficient traceability system supported by appropriate architectural solutions (Bechini et al., 2008).

In particular, a traceability system must support information tracking and tracing. Tracking is the informative process by which a product is followed along the supply chain keeping records at each stage, from the production to the transformation and distribution process. Tracing is the reverse process of tracking.