Chapter 5
A Virtual Supply Chain Architecture to Grant Product Transparency in Agribusiness

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ABSTRACT

Especially in the food sector, fraud and counterfeiting are affecting the trust of consumers, who are more and more oriented to chose products basing on quality and traceability attributes rather than the price. Recently, the Electronic Product Code Information Services (EPCIS) standard was introduced to provide specifications for the representation of product traceability information. The collection and analysis of such information allows supply chains to be monitored and controlled through virtualization. Several applications of EPCIS were presented in literature, even if most of them are mainly focused on enabling technologies, with less emphasis on assessing how the available information can be used for a control at a higher level. This chapter review the relevant literature available on this topic, and present an architecture allowing the traceability of information about products throughout the entire supply chain by exploiting both the EPCIS standard and a NoSQL database. An application showing the potentiality of the proposed system in a case study is also reported.

INTRODUCTION

Today, consumers pay more and more attention to product quality and transparency of food ingredients, origins and production processes. Also, due to the rise of foodborne diseases, consumers in the food sector are even more interested in having ensured food quality and safety (D'Angelo et al. 2014). This requires knowing the origin of the product and its pathway from the producer to the final seller. Consumers are oriented to chose products basing on the credence attributes rather than the price, and fraud and counterfeiting cause the lost of consumers' trust. For this reason, the problem of integrating data through the supply chains is becoming an important research topic (Badia-Melis et al. 2015). Food

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traceability systems allow for all supply-chain actors and the National regulatory authorities to identify the source of a food quality problem and initiate procedures to remedy it. To guarantee the safety and trust of consumers, a strong collaboration along the supply chain is needed (Rota et al. 2013).

Even if traceability of products has been introduced since the 1990s (Cheng & Simmons, 1994), only large enterprises, characterized by a considerable use of information and communication technology, employ efficient and automated systems (Gandino et al. 2009). Small enterprises only rarely implement supply chain management systems, since for them, adding traceability to their normal operation has caused the decrease of efficiency and the increase of costs (Cimino & Marcelloni, 2012). For these reasons, a considerable challenge is to develop systems specifically suited for small-scale enterprises.

By recording product transitions, barcodes and Radio Frequency Identification (RFID) have provided partial solutions to this issue (Kelepouris et al. 2007, Solanki & Brewster 2014). Traceability of food product in the supply chain has gained considerable importance, particularly following a number of food safety cases during delivery (Abdul Kadir et al. 2015). However, companies and organizations today are not able to manage an extended network of suppliers and distributors. Thus, fraud and counterfeiting are rising and are difficult to discover.

The Electronic Product Code Information Service (EPCIS) is a standard that provides specifications to keep track of products (Främling et al. 2013). Food supply chains handle a large variety of objects, depending on the type of food product and the stage of the supply chain. At the farm, main objects are seeds, feed, fertilizers, and farm resources. After processing, they become discrete objects when they are packaged, shipped and distributed to retailers. The collection and analysis of the product information from different stages allows supply chains to be virtualized and remotely monitored, optimized and controlled (Verdouw et al. 2016). By utilizing expressiveness of the EPCIS standard, all the processes are visible to the users so that they can control the safe of foods, e.g., by avoiding dangerous place-of-origins (Byun & Kim 2015). To reach this goal, all the roles involved have to incrementally provide additional information regarding the product stages. EPCIS proposes a mechanism to exchange and share data, but the semantics of data is informally defined and its interpretation is left up to the individual implementing engines (Solanki & Brewster 2015).Hence, the aim of this chapter is to present a collaborative architecture to allow the traceability of information throughout the entire supply chain.

To this aim, the chapter revises the relevant and most recent literature on the topic, and it describes the available standards to track products and the events they generate inside the supply chain. The need of storing a huge amount of heterogeneous data suggests the adoption of a non relational database to better manage the data generated by the system. Thus, also a section recalling the advantages of NoSQL databases in comparison with relational ones is present. Finally, the procedure to map EPCIS events to non relational documents in a case study is reported. The last section illustrates conclusions and states future works.

LITERATURE REVIEW

Despite technical and cost challenges, the application of RFID in supply chain management is growing around the world (Musa & Abba Dabo 2016). Particularly, RFID was introduced in the agrifood industry (Gandino et al. 2009), also together wireless sensor networks for monitoring the environment conditions (Exposito et al. 2013). D’Angelo et al. (2014) highlighted that another key issue to add values