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Comprehensive and quantifiable granularity: A novel model to measure agro-food traceability

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A B S T R A C T

Recent developments in the legal establishment and the market have motivated more agro-food companies to implement traceability systems (TS). TS play an important role not only for planning system implementation before development, but also for analyzing system performance after using the system. A novel agro-food TS model is presented here, based on comprehensive and quantifiable granularity concepts. A 2-layer index system was established; the first layer was mainly factors such as precision, breadth, and depth, and the second layer included seven indicator sub-factors: external trace units, internal flow units, IU conversion, information collection content, information update frequency, forward tracking distance, and backward tracing distance. An indicator's overall score was scaled with five contributing scores that graded the assignment method. Indicator weight was confirmed with the AHP method. The weight values of the seven indicators were 0.1985, 0.1141, 0.0872, 0.1870, 0.1248, 0.1442, and 0.1442, respectively. A weighted sum model was adopted to calculate the evaluation value. A high evaluation value indicated high granularity. The granularity model was applied in two enterprises, here identified as WPF and WFPE, which were located at different stages in wheat-flour supply chain. The survey results showed that WFPE should invest more in tracing equivalent granularity than WPF should because it involves multi-stage processing, a complicated supply chain structure, it is a large enterprise, and operates in a strict regulatory environment. Furthermore, WFPE was motivated to implement a high granularity level because of benefits in supply chain management, market and customer response, and recall and risk management. In the future, an updated granularity evaluation model that could combine enterprise characteristics and uncover hidden costs and benefits will be studied further.

1. Introduction

Some astounding events, such as the BSE case in the early to mid-1990s (Wales, Harvey, & Warde, 2006), and the 1999 dioxin contamination of chicken feed in Belgium (Bernard et al., 2002), have focused attention on the topic of food safety (Bertolini, Bevilacqua, & Massini, 2006). Traceability is an effective method to ensure food safety and quality and to reduce the costs associated with recalls (Regattieri, Gamberi, & Manzini, 2007). Traceability is defined in international standards, in legislation, and in some dictionaries; the most cited standalone definition was formulated in a scientific article (Badia-Melis, Mishra, & Ruiz-García, 2015). By combining parts of existing definitions, Olsen and Borit (2013) offered a new definition: the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications.

In recent years, traceability systems research has been carried out on various topics, such as traceable technology (Li, Qian, Yang, Sun, & Ji, 2010; Pierini, Fernandes, Diniz, de Araújo, Di Nezio & Centurión, 2016), system development (Feng, Fu, Wang, Xu, & Zhang, 2013; Thakur & Hurburgh, 2009), traceability modeling (Comba, Belforte, Dabbene, & Gay, 2013; Van der Spiegel, Sterrenburg, Haasnoot, & van der Fels-Klerx, 2013), operating mechanisms, and consumers' perceptions (Dabbene & Gay, 2011; Kim & Woo, 2016). Rapid development of information and

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