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Research report

Traceability information carriers. The technology backgrounds and consumers' perceptions of the technological solutions

Polymeros Chrysochou [a,*], George Chryssochoidis [b], Olga Kehagia [b]

[a] MAPP, Aarhus School of Business, Aarhus University, Haslegaardsvej 10, DK-8210 Aarhus V, Denmark
[b] Agricultural University of Athens, Laboratory of Agribusiness Management, Iera Odos 75, GR-118 55 Athens, Greece

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ABSTRACT

The implementation of traceability in the food supply chain has reinforced adoption of technologies with the ability to track forward and trace back product-related information. Based on the premise that these technologies can be used as a means to provide product-related information to consumers, this paper explores the perceived benefits and drawbacks of such technologies. The aim is to identify factors that influence consumers' perceptions of such technologies, and furthermore to advise the agri-food business on issues that they should consider prior to the implementation of such technologies in their production lines. For the purposes of the study, a focus group study was conducted across 12 European countries, while a set of four different technologies used as a means to provide traceability information to consumers was the focal point of the discussions in each focus group. Results show that the amount of and confidence in the information provided, perceived levels of convenience, impact on product quality and safety, impact on consumers' health and the environment, and potential consequences on ethical and privacy liberties constitute important factors influencing consumers' perceptions of technologies that provide traceability.

Introduction

Traceability has become a rather important and essential tool in the agri-food sector. Food scare incidents, increased demand for differentiated food products as well as innovations in quality measurement and tracking and information management technologies have pushed traceability to the forefront of the food supply chain (Hobbs, 2006). Moreover, in today's competitive global marketplace, producing a sound product is not enough to ensure a company's viability. Traceability systems are often considered as a prerequisite for a business to be able to manage the physical flow of its products, increase speed and efficiency throughout the supply chain, and meet consumers' expectations as regards product quality and safety (Leat, Marr, & Ritchie, 1998). Consequently, technological solutions (hereafter referred to as "traceability information carriers"), which store and carry food product related information, have been introduced.

A universally known traceability information carrier applied in the food supply chain is the barcode system. During the last decade, RFID tags have been introduced that are said to have a strong potential to replace the barcode technology (Jones, Clarke-Hill, Hillier, & Comfort, 2005; Kärkkäinen, 2003; Kelepouris, Pramatari, & Doukidis, 2007; Sellitto, Burgess, & Hawking, 2007). Moreover, other traceability information carriers are being implemented in the food supply chain, such as edible tags, DNA-based technologies and e-paper tags. Such technologies are less known to the public, but are likely to be applied to a greater extent in the future. The success of such carriers primarily depends on the benefit that food companies are able to derive, as well as on consumers' perceptions of such technologies.

From a consumer perspective, benefits of traceability information carriers have to be thoroughly communicated in order to be well received. Therefore, investigating the perceived benefits and drawbacks of such technologies, as well as the factors that may influence consumer perceptions, will provide a better understanding of their potential success. On the other hand, the increasing vigilance and even enmity of consumers poses additional challenges for food supply chain managers and marketers who are concerned about ethical and legal aspects of technology use. Nevertheless, previous research that has focused on investigating drivers of consumers' perceptions of traceability information carriers is scarce.

Consumer research on traceability has primarily focused on exploring consumer preferences and willingness-to-pay for mandatory and voluntary labelling programs associated with credence attributes related to preferences for traceability assur-

* Corresponding author.
E-mail address: polyc@asb.dk (P. Chrysochou).

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ances and origin (Bernues, Olaizola, & Corcoran, 2003; Dickinson & Bailey, 2002, 2005; Dimara & Skuras, 2003, 2005; Hobbs, Bailey, Dickinson, & Haghiri, 2005; Kehagia, Linardakis, & Chryssochoidis, 2007; Loureiro & McCluskey, 2000; Loureiro & Umberger, 2003, 2007; Roosen, Lusk, & Fox, 2003; Verbeke & Ward, 2006; Umberger, 2004; Umberger, Feuz, Calkins, & Sitz, 2003). On the other hand, little has been reported on how consumers perceive and further accept technologies and systems that provide traceability information. Likewise, the success of implementation of traceability information carriers may depend on such concerns and should be taken into account by food companies and retailers.

Since RFID technology is perceived as promising, a considerable number of academic researchers and market research companies have investigated consumer perceptions of RFID tags (e.g. Angeles, 2007; Günther & Spiekermann, 2005; Juban & Wyld, 2004). Another stream of research has focused on ethical concerns and privacy rights regarding the implementation of RFID tags (e.g. Curtin, Kauffman, & Riggins, 2007; Kelly & Erickson, 2005).

Traceability carriers can provide additional benefits to consumers in comparison to traditional food labelling schemes. It is argued that traceability enhances product safety and quality (Gellynck & Verbeke, 2001; Hobbs, 2004; McKean, 2001; Verbeke, 2001). It also ensures product authenticity in cases such as region of origin labelling, organic produce or GMO identification. Furthermore, it can benefit specific consumer groups, such as consumers with food allergies (Cornelisse-Vermaat et al., 2008).

Finally, an indirect approach, but a rather relevant one to traceability information carriers, has been followed in the field of food product packaging and the evaluation of label information about functional cues of products (Lähteenmäki & Arvola, 2003; Mikkola et al., 1997), as well as communication and environmental cues (Bech-Larsen, 1996; Thøgersen, 1999). In an early Danish survey by Bech-Larsen (1996) it was found that functional cues have a strong influence on consumers' purchase decisions in comparison to communication and environmental cues. In this respect, a traceability information carrier, if viewed as a communication cue, may not be regarded as important for influencing consumers' decision making.

The present paper is based on the premise that traceability carriers can be used as a means to provide consumers with additional information. For this purpose, a qualitative study was conducted across twelve European countries in order to explore consumers' perceptions of a set of four different traceability carriers. The aim is to reveal the factors that influence consumers' perceptions of the technologies used in the food supply chain that are able to provide traceability information. The objective of the study is to identify benefits and drawbacks that such technologies provide from a consumer perspective.

The structure of this paper is as follows. The first part provides a brief overview of the development of traceability in the food supply chain. The paper continues with a review of the main technological advancements with respect to traceability carriers. Then, the method and research design used in this study are described, followed by the research findings. Finally, conclusions and implications for the food industry are provided.

Traceability in the food supply chain

In the food supply chain there are increased demands for traceability. The outbreak of recent food safety incidents has highlighted the importance of being able to track forward and trace back product information throughout the supply chain with the purpose of decreasing product risk and enabling recalls (Cheek, 2006; Opara & Mazaud, 2001). From this perspective, traceability forms a key principle adding up to food safety and consumer confidence (Gellynck & Verbeke, 2001; Hobbs, 2004; Kehagia, Chrysochou, Chryssochoidis, Krystallis, & Linardakis, 2007; McKean, 2001; van Rijswijk, Frewer, Menozzi, & Faioli, 2008; Verbeke, 2001). Moreover, traceability adds value to food products by enhancing food quality through labelling of experience and credence food attributes (Buhr, 2003; Dickinson & Bailey, 2002; Golan, Krissoff, & Kuchler, 2002; Loureiro & Umberger, 2007).

Traceability has often been reinforced with regulations that reveal its importance, thus becoming mandatory within the food supply chain in many countries. However, there are differences across countries as regards the amount and type of information to be recorded and the product categories that are controlled. In the EU, traceability has been enshrined in a number of regulatory initiatives, with the General Food Law addressing traceability requirements; this came into effect January 2005 (European Union, 2002; Schwägele, 2005). Traceability is established at all stages of production, processing and distribution and covers food, feed, food-producing animals, and any other substance intended or expected to be incorporated into a food or feed. In the US, country of origin labelling (COOL) requires relevant commodities sold at certain retail establishments to be labelled as to their country of origin (Dickinson & Bailey, 2002; Smith et al., 2005). The latest amendment (August 2008) came into force 30 September 2008 covers beef, lamb, pork, chicken, goat meat, perishable agricultural commodities, ginseng, pecans, macadamia nuts and peanuts (Federal Register, 2008). Meat and chicken products sold in restaurants, as well as processed products, are exempted from the law. In Japan, the Beef Traceability Law that took effect 1 December 2004, requires processors, distributors and retailers to provide traceability information from the slaughterhouse to the retail outlet (Clemens, 2003).

As traceability progressively becomes mandatory, the food industry is called to implement traceability systems. In practice, traceability systems are record keeping procedures showing the path of a particular product or ingredient from supplier(s) to outlet, through all the intermediate steps that process and combine ingredients into new products, and through the supply chain to consumers (Food Standards Agency, 2002). The basic characteristics of traceability systems (i.e. identification, information and the links between) are common in all systems, independently of the type of product, production and control systems that are served. In their simplest form, traceability systems are paper-based, while more advanced ones are computer-based. However, a good traceability system does not necessarily relate to advanced technological solutions. Information technology (IT) has a complementary but rather important role that enhances the effectiveness of record keeping and data access. The increased efficiency, effectiveness and security of IT-enabled systems are recognised and gradually being rolled out throughout the food supply chain.

Important aspects of an efficient traceability system are the costs of implementation and establishment of standards. The cost of establishing a traceability system may vary across businesses and sectors; it depends on the complexity of the food chain, the amount of information to be recorded and the technology requirements (Roos, Dulsrud, & Norberg, 2004). Nonetheless, the benefits of a system should be considered in cases where food crises may result in loss of consumer confidence (Davies, 2003; Roos et al., 2004). On the other hand, the implementation of a traceability system requires standards that are able to store the necessary information. In this sense, global standards are developed in the market, allowing item identification for global tracking and tracing of food products (Cheek, 2006).

Traceability information carriers

As voluntary and mandatory labelling information expands mainly as a result of widening traceability requirements by