Abstract. *The food quality and safety is influenced by all food operators from the food supply chain, therefore there are numerously factors that must be observed and taken into consideration. Moreover, if accidentally the food becomes dangerous for human consumption, it is necessary to be taken actions to pull out the compromised food from the market and to identify where is located all other compromised food batches across the food supply chain in order to eliminate the possibility to spread the compromised food and to minimize the consequences. The basic requirement in order to facilitate those actions is represented by the inter-organizational communication and sharing information between all organizations across food supply chain, consequently by the existence of an information system that must allow those capabilities.*
This paper presents main aspect related to data and information quality, sharing information and will discuss the possibility to share information between organizations involved in food supply chain in order to enhance capabilities of food traceability systems. Conclusions and future directions of the research are discussed.

Keywords: data and information quality, information sharing, food traceability system, inter-organizational information systems.

FOOD TRACEABILITY SYSTEMS AND INFORMATION SHARING IN FOOD SUPPLY CHAIN

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1. Introduction

Because the amount of data and information interchanged between the organizations has started to increase exponentially, mainly because of the new capabilities offered by developments from information and communication technology (IT&C), the shared information topic become an important research subject for both academics and practitioners (Li, 2002). Due to the numerously reasons that can make information sharing to be valuable in a supply chain (Gaur et al., 2005), many of the recent paper began to be focused on the subject of shared information between the actors from the supply chain, and to analyze the concept of data or information quality. In the same time, two issues generate discussion between researchers: the concept of quality, because was debated and discussed for many centuries (Reeves and Bednar, 1994), having many approaches in the literature (Nelson et al., 2005) and the concepts of data and information. Although data and information represent fundamental concepts in many academic disciplines, the definitions vary a lot from a discipline to another discipline. Therefore is a major probability to make confusions between concepts, Drucker (1995) considering that "*it is all too easy to confuse data with knowledge and information technology with information*".

Raghunathan (2001) considers that when the information cannot be deduced or obtained based on other data or information represents the only situation when the shared information may become valuable.

It is obvious that in order to share information it is necessary to be built and implemented an information system (IS) that must facilitate and permit this activity. Such type of IS are called inter-organizational information systems (IOIS) and according to Barrett and Konsynski (1982) represent "*systems that involve resources shared between two or more organizations*".

Food safety and quality is a high priority for many governments, private or public non-governmental organizations, food and feed business operators because some incidents have affected population during last years, therefore were build and implemented regulations and standards in order to guarantee that food fulfill minimum quality and safety requirements. The common element of all these regulations and standards is represented by the food traceability which implies a food traceability system.

The establishment of the European Food Safety Agency (EFSA), by the European Union Regulation (EC) 178/2002, represents one of the first steps at the EU level for defining a coherent framework at European level in order to implement in agriculture and food industry a set of rules more restrictively for food traceability.

According to article 18 from the Regulation (EC) 178/2002 of the European Parliament and of the Council *"food and feed business operators shall be able to identify any person from whom they have been supplied with a food, a feed, a food-producing animal, or any substance intended to be, or expected to be, incorporated into a food or feed. To this end, such operators shall have in place systems and*

procedures which allow for this information to be made available to the competent authorities on demand. Food and feed business operators shall have in place systems and procedures to identify the other businesses to which their products have been supplied. This information shall be made available to the competent authorities on demand".

As can be seen, because authorities are entitled to require traceability information from food and feed business operators, the building and implementation of a food traceability information system becomes a must. Moreover, in order to increase the speed of acquiring data into system and to reduce the possibilities of human errors during this process it is necessary to be designed, built and implemented information system that allow that data and information to be shared between all organization involved in food supply chain.

Paper will start by presenting main aspect related to data and information quality, sharing information and will discuss the possibility to share information between organization involved in food supply chain in order to enhance capabilities of food traceability systems.

2. Data and information quality

The main element created, stored and provided by the information systems, according to Devlin (1997), is represented by data. After the data are processed, by adding or creating new useful meanings, data are transformed into information, the information scope being to reduce uncertainty. The information user is the person who establishes if the result obtained after data processing represents information or not, the information valuation being a must because the managers can adopt inefficient and costly decisions based on inadequate information (Simmonds, 1981).

The development of information and communication technology (ICT) determine that the volume of collected and stored data to increase spectacular in last decades, therefore the risk of poor data quality is increasing (Watts et al., 2009), consequently, the data management process has become more and more complex. Haug and Arlbjørn (2011) consider that the possibility to collect, store and process huge amount of data, due to the latest hardware and software developments can represent a major cause for companies' data quality problems.

Nowadays, organizations can collect huge amounts of data, some of them are critical, some of them can be considered important, but not critical and other may be useful for future analyses, therefore it is a must to create organizational standards in order to define the minimum level of data quality for each category (Adelman et al., 2005). The concept of quality has some approaches, being assimilated with excellence, value, conformance to specifications, meeting and/or exceeding customers' expectations, each of these approaches having *"strengths and weaknesses in relation to measurement and generalizability, managerial usefulness, and consumer relevance."* (Reeves and Bednar, 1994). In the same time, there were studies that

identified and analyzed the impact of quality on some key elements: price, productivity, market share, cost and profit (Garvin, 1988; Reeves and Bednar, 1994) and how the quality can be influenced by: nature of organizational output, time and multiple constituencies (Reeves and Bednar, 1994).

During last three decades there were studies that have tried to identify dimensions of data quality:

- Ballou and Pazer (1985) identify four dimensions for measuring data quality: accuracy, timeliness, completeness, and consistency;
- Wand and Wang (1996) consider four dimensions of data quality: unambiguousness, meaningfulness, completeness, and correctness;
- Lee and Strong (2003) identify five dimensions: accessibility, relevancy, timeliness, completeness, and accuracy;
- Nelson et al. (2005) identify four dimensions: accuracy (having an extension: consistency), completeness, currency, and format;
- Haug and Arlbjørn (2011) identify three data quality categories: intrinsic, accessibility, and usefulness.

The main problems related with data quality can be summarized as follows (Adelman et al., 2005): (i) incorrect data, (ii) inaccurate data, (iii) business rule violations, (iv) inconsistent data, (v) incomplete data, (vi) non-integrated data.

It is obviously that the data processed by the information systems and, consequently, the information obtained are influenced by the data quality (Winkler, 2006). Information quality is measured from the perspective of a set of dimensions: (i) accuracy, (ii) completeness, (iii) currency and (iv) format (Wang and Strong, 1996). The consequences generated by a poor data quality can significantly negative influence the organizational performances by: customers lack of confidence (Pipino et al., 2002), incorrect inferences or alternatives and, consequently, poor decisions resulted in decision making process (Raghunathan, 1999; Kahn et al., 2003), user satisfaction (Nelson et al., 2005), increasing operational costs (Haug and Arlbjørn, 2011).

3. Information sharing

Kumar and Diesel van (1996) consider that in order to share a resource between two or more organizations it is necessary to clearly identify, define and standardize that resource, otherwise will be a lot of problems in accessing and using of the resource.

According to Li (2002), the vertical information sharing generates two effects:

- direct effect - over the organizations that are involved in sharing information;
- indirect effect - over the direct competitors of organizations involved in sharing information.

A proper environment for sharing information is represented by internet which can allow organizations to exchange data electronically or to interconnect their information system. The two possibilities mentioned before involve different approaches regarding the usage of IT infrastructure, having strengths and weaknesses. If the chosen method for sharing information is to exchange data electronically, the generated costs are lower because the involved information system does not interact directly, therefore the interconnection costs, the security costs and the costs associated with the management the common part of information systems are comparable with costs when information systems does not share information. On the other hand, because only interaction with the other organizations' information systems is limited to the file exchange and cannot be exploited the all capabilities of the other IS. If the chosen method for sharing information is to interconnect information systems there will be higher costs related to interconnection and security, but will be benefits related to the speed of updating and synchronizing all involved IS and will practically unlimited possibilities to exploit all capabilities offered by each information system that is interconnected. In the same time, according to Grover and Saeed (2007) the IT infrastructure must be compatible from the following points of view: compatibility of database management systems and compatibility of software.

4. Inter-organizational information systems and food traceability systems

Inter-organizational information systems were designed in order "to support and implement cooperation and strategic alliances between two or more organizations" (Johnson and Vitale, 1988), nowadays IOIS have "the potential to produce synergistic effects on supply chain performance" (Kim et al., 2011). Cost reducing, productivity improvements and a better product or market strategy are benefits obtained by implementing inter-organizational information system (Barett and Konsynsky, 1982). Moreover, in the food supply chain, an IOIS is essential in order to increase food safety and quality. Ariezo et al. (2008) consider that chain traceability system represents an inter-organizational information system designed to fulfill complete food traceability from farmers to distributors/retailers.

Accessibility, reliability, response time, flexibility, and integration represent the key factors that must be taken into consideration in order to evaluate the quality of the IOIS obtained by interconnection organizational information systems (Nelson et al., 2005).

In the same time, in any IOIS there are involved electronic data interchange (EDI), in order to facilitate the exchange data between information systems without human intervention (Nurmilaakso, 2008). The electronic data interchange process from an inter-organizational information system is presented in Figure 1.

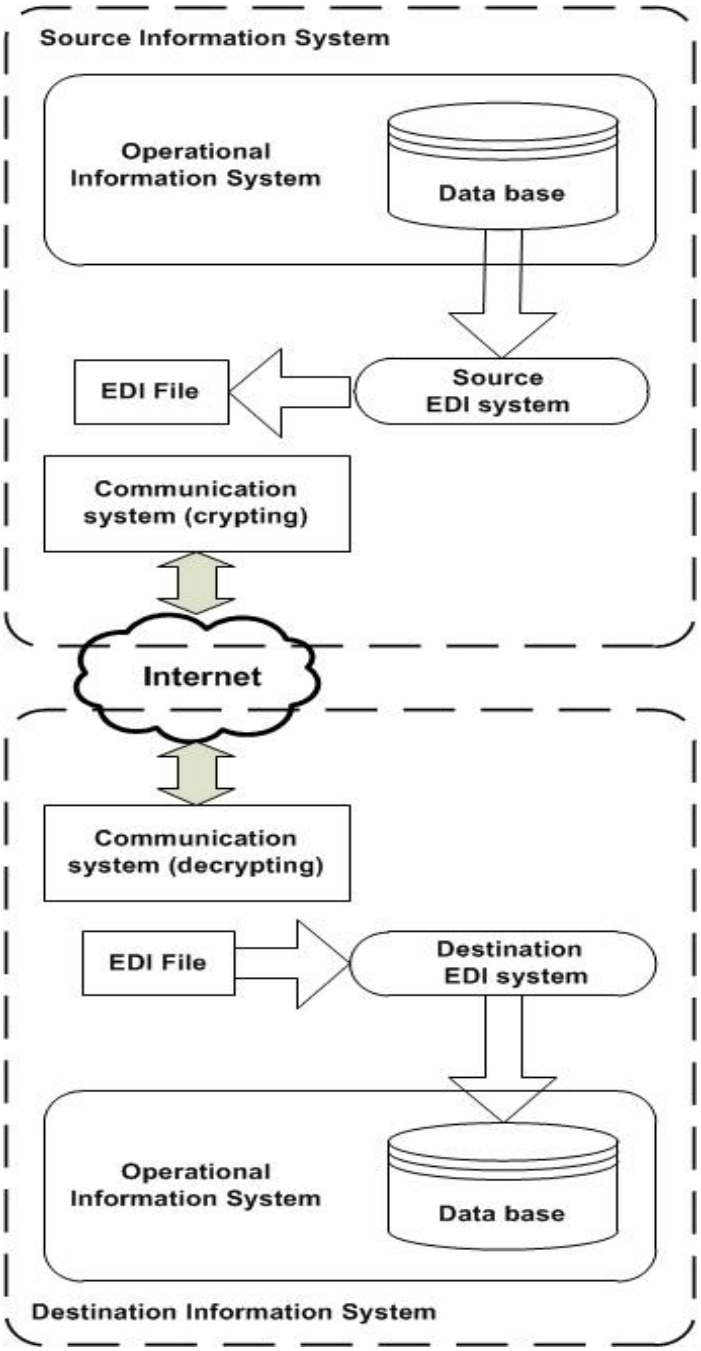


Figure 1. **Electronic data interchange in inter-organizational information system**

According to article 3 from the Regulation (EC) 178/2002 of the European Parliament and of the Council food traceability represents „*ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution*". Consequently, in order to have a full traceability on the food supply chain is necessary to interconnect all information systems belonging to all food operators that are involved on food supply chain and to build an inter-organizational information system. All business operators must adopt a proactive approach in order to manage food quality and safety by building and implementing traceability systems.

Mai el al. (2010) consider that the usage of chain traceability systems in agriculture and food industry, will determine that the necessary time for identifying all the movements and involved food processors for a food or foodstuff along the entire food supply chain to be significantly reduced, therefore the process of risk management is improved considerably. Gabbene and Gay (2011) consider that any chain traceability system built and implemented must fulfill the following minimum requirements:

- to store a complete and full log of history and locations for foodstuff on the entire food supply chain;
- to trace back the foodstuff on the food supply chain in order to identify where the problem appeared and which were the causes that have generated the problem in order to prevent similar situations.

An IOIS that involves all food operators from food supply chain can be assimilated with an e-commerce electronic system that combines the following types of e-commerce models: (a) business-to-business (B2B) – e-commerce between companies, (b) business-to-consumer (B2C) – e-commerce between companies and consumers; and (c) business-to-government (B2G) – e-commerce between companies and government organizations.

The reasons for combining these three types of e-commerce models in IOIS derived from the system's capabilities to facilitate data and information communication between food operators (farmers, processors, distributors, and retailers), between food operators and government or between retailers and final consumers.

Conclusions

The food quality and safety is influenced by all food operators from the food supply chain, therefore there are numerously factors that must be observed and taken into consideration. Moreover, if accidentally the food becomes dangerous for human consumption, it is necessary to be taken actions to pull out the compromised food from the market and to identify where is located all other compromised food batches across the food supply chain in order to eliminate the possibility to spread the compromised food and to minimize the consequences. The basic requirement in order

to facilitate those actions is represented by the inter-organizational communication and sharing information between all organizations across food supply chain, consequently by the existence of an information system that must allow those capabilities.

One of the key objectives for food traceability supply chain system is to provide and to ensure the visibility for all process from food supply chain and that can be fulfilled only if all food operators from food supply chain will interconnect their information system, will share data and information and will use electronic data interchange facilities. Obviously, the eradication of all food quality and safe risks is practically impossible, even these requirements are fully implemented and fully functional, but the potential risks are significantly reduced. Another advantage derived from sharing information among food operators is represented by increasing trust of final consumers in acquired food due to the visibility which can be provided by system.

Future researches must be focused also over the final consumers' feedback and how this feedback can be valorized in order to increase food quality and safety.

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References

Adelman, S., Moss, L., Abai, M. (2005). Data Strategy. Upper Saddle River, NJ, Addison-Wesley Professional

Arienzo, A., Coff,, C., Barling, D. (2008). The European Union and the Regulation of Food Traceability: From Risk Management to Informed Choice?. *Ethical Traceability and Communicating Food*, Springer Science +, 23-42

Ballou, D., Pazer, H. (1985). Modeling data and process quality in multi-input multi-output information systems. *Management Science*, Vol. 31, No. 2, pp. 150-162

Barrett, S., Konsynski, B. (1982). Inter-Organization Information Sharing Systems. *MIS Quarterly*, Vol. 6, Special Issue: 93-105

Dabbene, F., Gay, P. (2011). Food traceability systems: Performance evaluation and optimization. *Computers and Electronics in Agriculture*, Vol. 75, No. 1, pp. 139-146

Devlin, B. (1997). *Data Warehouse from Architecture to Implementation*, Reading, MA, Addison Wesley Longman

Drucker, P. (1995). *The Post-Capitalist Executive*: *Managing in a Time of Great Change*. New York, NY, Penguin

Garvin, D.A. (1988). *Managing quality: The strategic and competitive edge*. New York, NY, Free Press

Gaur, V., Giloni, A., Seshadri, S. (2005). Information Sharing in a Supply Chain under ARMA Demand. *Management Science*, Vol. 51, No. 6, pp. 961-969

Grover, V., Saeed, K.A. (2007). The impact of product, market, and relationship characteristics on interorganizational system integrationin manufacturer-supplier dyads. *Journal of Management Information Systems*, Vol. 23, No. 4, pp. 185-216

Haug, A., Arlbjørn, J.S. (2011). Barriers to master data quality. *Journal of Enterprise Information Management*, Vol. 24 No. 3, pp. 288-303

Johnston, R.H., Vitale, M.R. (1988). Creating Competitive Advantage with Interorganizational Information Systems. *MIS Quarterly*, Vol. 12, No. 2, pp. 153-165

Kahn, B., Strong, D., Wang, R. (2003). Information quality benchmarks: product and service performance. *Communications of the ACM*, Vol. 45, No. 4, pp. 184-92

Kim, K.K., Ryoo, S.Y., Jung, M.D. (2011). Inter-organizational information systems visibility in buyer–supplier relationships: The case of telecommunication equipment component manufacturing industry. *Omega - International Journal of Management Science*, Vol. 39, No. 6, pp. 667-676

Kumar, K., Diesel van, H.G. (1996). Managing Conflict and Cooperation in Interorganizational Systems. *MIS Quarterly*, Vol. 20, No. 3, pp. 279-300

Lee, Y.W., Strong, D.M. (2003). Knowing-Why About Data Processes and Data Quality. *Journal of Management Information Systems*, Vol. 20, No. 3, pp. 13-39

Li, L. (2002). Information Sharing in a Supply Chain with Horizontal Competition. *Management Science*, Vol. 48, No. 9, pp. 1196-1212

Mai, N., Bogason, S. G., Arason, S., Arnason, S. V., Matthiasson, T. G. (2010). Benefits of traceability in fish supply chains - case studies. *British Food Journal*, Vol. 112, No. 8-9, pp. 976-1002

Nelson, R.R., Todd, P.A., Wixom, B.H. (2005). Antecedents of Information and System Quality: An Empirical Examination Within the Context of Data Warehousing. *Journal of Management Information Systems*, Vol. 21, No. 4, pp. 199-235

Nurmilaakso, J.M., (2008). EDI, XML and e-business frameworks: A survey. *Computers in Industry*, Vol. 59, pp. p. 370–379

Pipino, L.L., Lee, Y.W., Wang, R.Y. (2002). Data quality assessment. *Communications of the ACM*, Vol. 45, No. 4, pp. 211-218

Raghunathan, S. (1999). Impact of information quality and decision-maker quality on decision quality: a theoretical model and simulation analysis. Decision Support Systems, Vol. 26, No. 4, pp. 275-286

Raghunathan, S. (2001). Information Sharing in a Supply Chain: A Note on Its Value when Demand is Nonstationary. *Management Science*, Vol. 47, No. 4, pp. 605-610

Reeves, C, Bednar, D.A. (1994). Defining quality: Alternatives and implications. *Academy of Management Review*, Vol. 19, No. 3, pp. 419-445

Simmonds, K., (1981). Strategic Management Accounting. *Management Accounting*, Vol. 59, No. 4, pp. 26-29

Wang, R.Y., Strong, D.M. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems*, Vol. 12, No. 4, pp. 5-34

Watts, S., Shankaranarayanan, G., Even, A. (2009). Data quality assessment in context: a cognitive perspective. *Decision Support Systems*, Vol. 48, No. 1, pp. 202-211

Winkler, W.E. (2006). Data Quality in Data Warehouses. *Encyclopedia of Data Warehousing and Mining,* Hershey, PA, Idea Group Publishing

*** Regulation (EC) No 178/2002 of the European Parliament and of the Council

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