

Scientometrics Analysis of Food Supply Chain Risk Assessment Literature Based on Web of Science Record 1996-2014

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Abstract—This paper presents the results of a study to assess crucial aspects and the strength of the scientific basis of a typically interdisciplinary, applied field: food supply chain risk assessment research. Our approach is based on an advanced scientometrics analysis that is a quantitative study of the disciplines of science based on published literature to measure interdisciplinary. This paper aims to describe the quantity and quality of the publication trends in food supply chain risk assessment. The publication under study was composed of 266 articles from database web of science. The results were analyzed based on date of publication, type of document, language of the documents, source of publications, subject areas, authors and their affiliations, and the countries involved in developing the articles.

Keyword—Food Supply Chain, Risk Assessment, Scientometrics, Web of science.

I. INTRODUCTION

BY increasing concern about risks to public health in Europe, customer confidence in food industry has been reduced. The Centre for Disease Control and Prevention [1] estimates 48 million food borne disease cases in United State annually, 128000 hospitalized people with a diagnosis of food poisoning and 3000 die in each year. In terms of monetary lost and medical costs, it ranges from \$6.5 to \$34.9 billion dollar annually. These figures led to put more effort in the safety monitoring of food supply chain [2]. The literature review by [3] reveals that previous studies in food safety is in each node and does not cover the whole supply chain. Furthermore, [4], in the study of product safety challenges in supply chain, argues that safety is a part of product life cycle management and research need to be further developed in hazard analysis and risk prevention strategies.

In addition to the general requirements of all supply chain, supply and delivery of perishable food have clearly specific requirements regarding the safety of the products [5]. Reference [6] characterizes food safety as a confirmation that food does not result in mischief to the purchaser when it is arranged and/or eaten by planned utilization. Usually these

requirements are defined through risk assessment in the different supply chain nodes.

The efforts are now in analyzing the entire chain of food industry from point of production, manufactures to distribution systems, retailers, and finally end consumers in order to correctly take into account the interface risks.

In recent years, research on supply chain risk management and risk assessment is gradually heating up. Especially the food industry which with a long supply chain and the increasing uncertainty of the supply and demand, the research of the food supply chain risk management and risk assessment is more urgent and important.

One of the known definitions of the term SCM that is presented by the Global Supply Chain Forum in 1994 and modified in 1998 is as follow [7]: “Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders.” Reference [8] has another vision of supply chain management: “Supply chain management consists of the entire set of processes, procedures, supporting institutions, and business practices that link buyers and sellers in a market place”.

Food supply chain is described with its unpredictability, which is a standout amongst the most essential reasons behind what makes the food safety complicated. There are a lot of connections in food network, interconnected with one another, and if one of them is out of work, the issues of food safety will be transfer, even putting dangers to human health. In this way, food supply chain safety is discriminating to ensure safe and efficient food supply.

The current food supply chain study mainly has a qualitative view of risk analysis factors, and develops some countermeasures to prevent or solve the risk. For example, [9] argued that food supply chain is different from other industry concerning the risk, because in food industry, risk mainly consists of technological risk, information risk, quality and safety risk. They presented five key points in order to strengthen the management of food safety: accelerate the procedure of agricultural standardization; apply the entire process supervision of inputs, develop a product traceability system, and establish agricultural production operator self-discipline mechanism, create a comprehensive system of product safety risk assessment [10]; and [11] support the use of traceability technology such as RFID in the food safety traceability in order to analysis of the food safety problems in

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the process of food supply chain.

Reference [12] argued the challenge to food business today is to manage and mitigate the risk through creating more resilient supply chains. Reference [13] studied the process of cold chain logistics, and key hazard points in the cold chain with the adoption of HACCP methodology. The study concludes using cold chain temperature monitoring technology leads to food safety improvement. Reference [14] investigates the food supply chain risk from different perspectives of food quality and safety risk, risk of logistics, food information risk, and system risk. They present a method for food supply chain risk assessment, and proposed the corresponding risk prevention measures.

Reference [15] analysed the current problems and situation of the food supply chain and suggest following points to solve food quality safety issues: improving the entire supply chain, scale of operation, national supervision, and set up professional logistics companies and logistics system. Reference [14] developed a model which analyses the various risks involved in a food supply chain with the help of interpretive structural modeling (ISM). The types of risks are clustered into five categories and risk mitigation is discussed. Reference [16] tested one of Scotland's major pork supply chains to identify the key risks and challenges involved in developing a resilient agri-food supply system, and found out supply chain vulnerability to risks reduce through horizontal collaboration amongst producers, and vertical collaboration with the processor and retailer. Reference [17] presented a model for using IT system with the help of RFID and central database to improve the food safety along the supply chain. However, due to the importance of the food supply chain safety; an awareness of the quantitative and qualitative trend of these studies is necessary for researchers so that they can be actively involved in this concept. "Scientometric studies" may help them to gain a proper perspective on publication trends [18], [19]. This article uses the Scientometric studies that mainly analyses of the research literature related food supply chain risk assessment, so that we can better evaluate the local and international research progress of food supply chain risk assessment as it is more illustrated in the following section.

II. MATERIAL AND METHODS

This descriptive research was performed using the scientometric approach. Scientometrics is the quantitative study of the disciplines of science based on published literature and communications. It intends to identify the emerging areas of scientific research, examine the development of research over time, and explore the geographic and organizational distribution of research [20]. This study is conducted on 266 articles on food supply chain risk assessment published between 1996 and 2014. Web of Science, the citation database of Thomson Reuters, was used to find the articles and extract the research findings. As Scopus and the citation databases of the Web of Science are the two most important tools for scientometrics studies [21], [22].

In order to find the articles, we first sought for equivalent terms for food safety in thesaurus, such as UNESCO and ERIC [23], [24]. Then we write a search formula, for advance search, to find out the whole articles of this subject area. Search formula = (food AND (risk OR hazards) AND (safety OR shelf life) AND (supply chain OR supply network)). Afterwards, we separated the documents based on title, abstract, and keywords. After that, the results were limited from 1996 to 2014 publications. Then, the contents of the documents were scanned to ensure their relevance. After excluding the unrelated documents or records with poor relevance, the researchers were left with 266 documents to analyze. The first phase of the analysis included publication date, document types, language, authors and their affiliations, and the countries where the articles were developed. Then, the subject areas of the documents (in total) were analyzed according to their publication dates. After that, publication sources of the documents were identified. Citation indicators formed the next phase of the investigation in the present study. It is necessary to mention that all the search and retrieval operations were performed on 25 to 28 September, 2015.

III. RESULTS OF THE STUDY

According to the results, the first article to be found on food supply chain risk assessment belonged to 1996. There were few documents (36 records, %13.53) on food supply chain risk assessment from 1996 to 2004. The results from 1996 to 2014 (266 documents) have been presented in Fig. 1. According to this figure, with a negligible number of ups and downs, the number of publications on food safety increased steadily from 1996 to 2014, with the greatest number occurring in 2013.

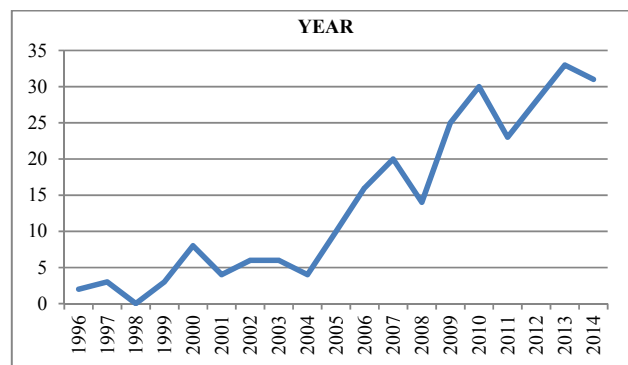


Fig. 1 Distribution rate of food supply chain risk assessment publications based on the date of publication

Data analysis based on document types indicated that out of the 266 documents under study, 199 (64%) were articles and 82 (26%) were proceeding paper. The remaining 31 items (10%) belonged to other types of documents (Fig. 2).

Considering the language of documents, 260 documents (97.74%) were published in English, 2 in German and 4 articles in other languages.

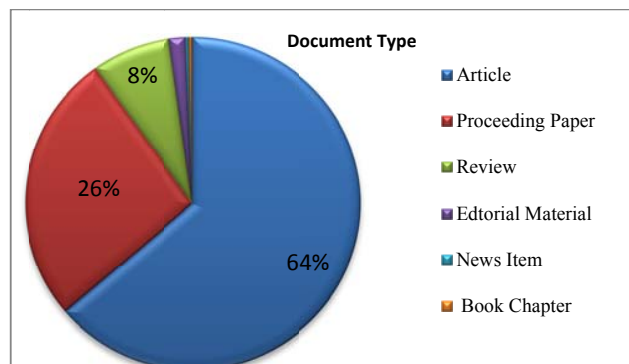


Fig. 2 Distribution rate of food supply chain risk assessment publications based on document types

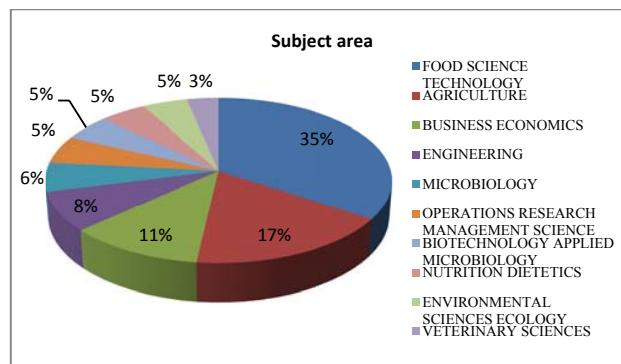


Fig. 5 Distribution rate of food supply chain risk assessment publications based on Subject area

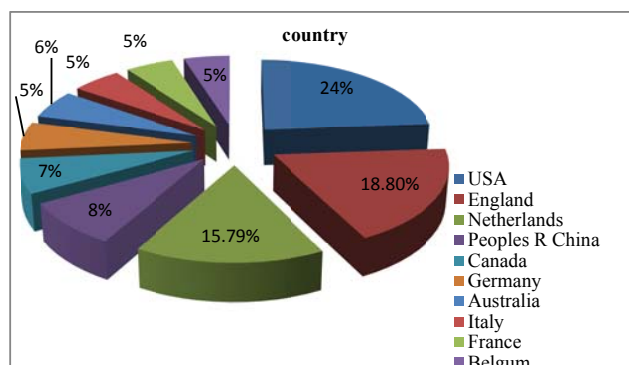


Fig. 3 Distribution rate of food supply chain risk assessment publications based on their affiliated countries

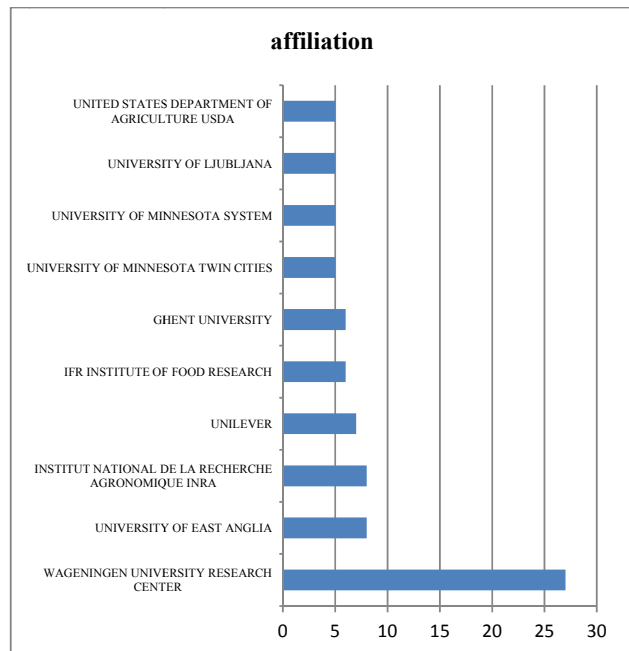


Fig. 4 Distribution rate of food supply chain risk assessment publications based on their affiliation

Distribution of the countries publishing the documents has been presented in Fig. 3. Accordingly, the United States with 64 documents (24%), the England with 50 documents (18.80%), and Netherlands with 42 documents (15.79%) had the greatest contribution to publishing the documents.

According to the results, the most prolific author was van der Fels-Klerx, HJ from Netherlands with 9 documents. He is active in the field of Food Quality. According to Scopus reports, his total products (126 records) received 4304 citations with 34 h-index.

Wageningen University Research Center with 27 documents (10.15%) was the most active affiliation in food supply chain risk assessment in the world. Distribution of the documents' affiliations has been shown in Fig. 4.

A thematic analysis of the study results showed that the greatest number of documents belonged to Food Science Technology with 115 documents (35%) followed by Agriculture with 58 documents (17%), Business Economics with 38 documents (11%), Engineering with 26 documents (8%).

Regarding the source of publication, the greatest number of international publications (15 documents, 5.63%) was published in Acta Horticulturae published by International Society for Horticultural Science, with SJR of 0.22 in 2014. After that, the greatest number of publications (12 documents, 4.51%) appeared in the International Journal of Food Microbiology, with SJR of 1.33 in 2014 [25].

In order to identify the trends related to the citation analysis of food supply chain risk assessment, the necessary data were obtained based on the documents' publication years. According to the results, from early 1996 to 2014 (when the data were retrieved), the 266 documents had received a total of 3309 citations, implying an average of 174.16 citations per year and an average of 12.44 citations per document.

According to the H-index, 28 documents were above the green horizontal line. The rate of food safety citation has been presented in Fig. 6. Based on this figure, the 2014 productions received the largest number of citations.

The most cited articles along with the average citations per year in the world have been shown in Table I.

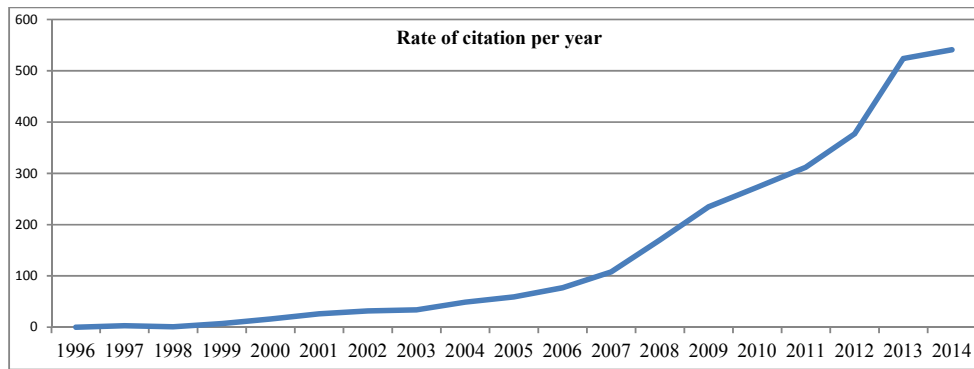


Fig. 6 Distribution rate of citation in food supply chain risk assessment publications

TABLE I

THE MOST CITED ARTICLES BASED ON THEIR AVERAGE CITATIONS PER YEAR IN FOOD SUPPLY CHAIN RISK ASSESSMENT

Row	Bibliographic information	Year	Author	Total citations	Average citations per year (approximations)
1	Worldwide occurrence of mycotoxins in commodities feeds and feed ingredients. 2007	2007	Binder, E. M.; Tan, L. M.; Chin, L. J.; et al	224	32
2	Animal Feed Science And Technology, 137(3-4), p 265-282.				
2	Emerging foodborne pathogens. international journal of food microbiology, 2002	2002	Tauxe, RV	183	15.25
	78(1-2), p 31-41.				
3	The Humboldt Current System of northern and central Chile. Oceanography And	2007	Thiel, Martin; Macaya, Erasmo C.; Acuna, Enzo; et al	180	25.71
	Marine Biology, 45(45), p 195-344.				
4	Causation of Crohn's disease by Mycobacterium avium subspecies	2000	Hermon-Taylor, J; Bull, TJ; Sheridan, JM; et al.	149	10.64
	paratuberculosis. Canadian Journal Of Gastroenterology, 14(6), p 521-539.				
5	Corporate social responsibility in the supply chain: An application in the food	2006	Maloni, Michael J.; Brown, Michael E.	131	21.83
	industry. Journal of Business Ethics, 68(1), p 35-52.				
6	The Belgian PCB/dioxin incident: Analysis of the food chain contamination and	2002	Bernard, A; Broeckaert, F; De Poorter, G; et al.	107	8.91
	health risk evaluation. Environmental Research, 88(1), p 1-18.				
7	Occurrence and Partitioning of Cadmium, Arsenic and Lead in Mine Impacted	2009	Williams, Paul N.; Lei, Ming; Sun, Guoxin; et al.	93	18.8
	Paddy Rice: Hunan, China. Environmental Science & Technology, 43(3), p 637-642.				
8	Unraveling The Food Supply Chain: Strategic Insights From China And The	2008	Roth, Aleda V.; Tsay, Andy A.; Pullman, Madeleine E. et al	87	14.5
	2007 Recalls. Journal of Supply Chain Management, 44(1), p 22-39.				
9	Measuring and monitoring animal welfare: Transparency in the food product	2003	Blokhuis, HJ; Jones, RB; Geers, et al	86	7.81
	quality chain. Animal Welfare, 12(4), p 445-455.				
10	Ochratoxin A: Its cancer risk and potential for exposure. Journal of Toxicology	2006	Clark, HA; Snedeker, SM.	81	10.125
	and Environmental Health-Part B-Critical Reviews, 9(2-3), p 265-296.				

IV. DISCUSSION AND CONCLUSION

From 1996 to 1999, there were just few documents in the food supply chain risk assessment domain, and from 1999 to 2004 there was a slight rise trend toward more publications with a negligible amount of fluctuation. However, after 2004 to 2014 we can see almost a sharp growth in the literature quantity.

The analysis of data based on document types indicated that, of the 266 documents, 199 (64%) were articles and 82 (26%) were proceeding paper. The 260 documents (97.74%) were published in English and the rest presented in other languages. The United States with 64 documents (24%), the England with 50 documents (18.80%), and Netherlands with 42 documents (15.79%) had the greatest contribution to publishing the documents. Wageningen University Research Center with 27 documents (10.15%) was the most active affiliation in food supply chain risk assessment in the world.

The results highlight the multidisciplinary nature of food supply chain risk assessment. As the greatest number of documents belonged to Food Science Technology with 115

documents (43.23%) followed by Agriculture with 58 documents (21.80%), Business Economics with 38 documents (14.28%), Engineering with 26 documents (9.77%), that shows the limitation of Engineering aspects of the topic.

This study provided some insights on the publication trends of food supply chain risk assessment, but for further information, it is necessary to perform additional scientometric studies, using Scopus or other citation databases such as Google Scholar. In addition, bearing in mind the increasing influence of the food safety on people's life, researchers from different academic fields such as supply chain, risk assessment, engineering, and sociology are recommended to give more priorities to food safety studies.

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