

FFI Report

The Role of Supply Chain Management in Food Fraud Prevention

November 9, 2018 -- By Bahar Aliakbarian Ph.D. & John Spink, PhD

Abstract

This report provides fundamental information about the concept of Supply Chain Management and Food Fraud Prevention. This is the first review that provides information about how the integration of the principles of Supply Chain Management theory and the Food Fraud Prevention strategies could reduce opportunities for fraudsters to penetrate the supply chain.

The research justification for this report is that food fraud is an urgent and evolving issue that is complex and requires interdisciplinary involvement to create a holistic and all-encompassing approach to prevention. While food fraud has been identified at least as far back as 400BCE, a series of more recent incidents have demonstrated the increased severity of public health and economic impacts. Several of the most impactful recent incidents include (Spink and Moyer, 2011):

- 2004 – Sudan Red carcinogen colorant in paprika and other spices (adulterant-substance)
- 2007 – Melamine in infant formula and pet food (adulterant-substances)
- 2012 – Horsemeat in beef (adulterant-substance)
- 2013 and ongoing – More incidents that are being publically identified as “Food Fraud”

When considering interdisciplinary approaches, one critical academic discipline that should be included is business and, in particular, supply chain management. This report is a primer – or basic overview – of food fraud, an explanation of the focus on prevention with respect to the theories and role of supply chain management, and to finally explain the role of supply chain management in food fraud prevention. This review is a foundational report that is intended to be incorporated into a series of research projects that considers more complex and more interdisciplinary issues such as the role of traceability, regulators and enforcement, industry coordination, and the role of the consumer.

This report will first review the scope and focus of the academic discipline of Supply Chain Management (SCM) which is not just a casual review of managing a supply chain. Next, there will be a review of food fraud and the prevention focus. These two reviews will be the foundation for considering *the role of supply chain management in food fraud prevention*.



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Supply Chain Management

Supply Chain Management (SCM) is the knowledge and capability of planning and controlling all techniques and technologies involved in procurement, conversion, transportation, and distribution across the supply chain. Supply Chain Engineering was first coined during World War II through the integration of Industrial Engineering and Operations Research with the aim to address supply chain and logistics issues. The term Supply Chain Management was framed in the early 1980s and revolutionized to SCM 2.0 in the late 1980s following the globalization and specialization era. Traditionally, SCM was only intended to generate cost-effective products and high-performance business models within a legal supply chain without receiving any proper feedback from customers and competitors. The term “Value Chain” was first introduced by Michael Porter in 1985. He created the Value Chain framework (Figure 1) as a model to analyze specific activities that could create value and competitive advantages for firms. The primary activities of Michael Porter's Value Chain are inbound logistics, operations, outbound logistics, marketing and sales, and service. The goal of the five activities is to create value that exceeds the cost of conducting that activity, therefore generating a higher profit.



Figure 1. The basic Model of Porter's Value Chain framework (adapted from (Porter 1985))

In the era of globalization, supply chains are no longer limited to one country. Modern supply chains are cross-border matrices of different onsite and offsite components and include all functional areas of business and several areas from outside of business. Closs and Mollenkopf in 2004 proposed the 21st Century Logistics framework. In their framework, they identified different firm competencies critical for logistics and supply chain management. They classified the leading competencies to high supply chain performance into operational, planning, and behavioral processes, each of them composed of multiple underlying capabilities.

Supply Chain Management has undergone rapid evolution over the past quarter of a century driven by changes in the business environment, technology, economics, and customer preferences. Stevens and Johnson in 2016 represented supply chain management evolution since 1989. As they discussed in their report, the internal integration phase focused on the balance of supply and demand within the constraints of the business plan with the scope of commercial, production, technical, purchasing, finance, and materials management and was underpinned by joined-up thinking, working, and decision

making. External integration includes supplier integration, distribution integration, and customer integration with the aim to build communication channels and trust, which facilitates more extensive knowledge sharing, to reduce logistics and distribution costs and provide increased demand visibility as well as leveraging the supply chain's capabilities as part of the customer proposition. The last step in the evolution of SCM is the transition to evolved and collaborative supply chain smaller networks that are more easily managed and are referred to as clusters.

A corporate management function plays a key role in improving a firms' security practices (Manuj and Mentzer, 2008). Clear and robust policies and decisions that can prevent an intentional disruption and reduce the long-lasting effect of an unintentional event can be made by managers. Security management is one of the greatest drivers of efforts to increase supply chain security.¹ Closs and McGarrell (2004) define supply chain security management as: *The application of policies, procedures, and technology to protect supply chain assets (product, facilities, equipment, information, and personnel) from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the supply chain.* The aim of this resilient supply chain framework is proactive to minimize supply chain disruption as well as prompt response and recovery from the incident.

Complex global supply chains are vulnerable to both unintentional (e.g., industrial accidents, inherent risks, or natural disasters) and intentional disruptions (e.g., theft, contamination sabotage, or a terrorist attack). Within the complicated and global supply chain operations, all types of product fraud can occur. These types of product fraud include intellectual property rights counterfeiting, tax avoidance smuggling, stolen goods, mislabeling, misrepresentation such as the weights, substandard or inferior versions, unauthorized production or overruns, as well as a range of adulterant-substances that include substitution, replacement, and dilution.

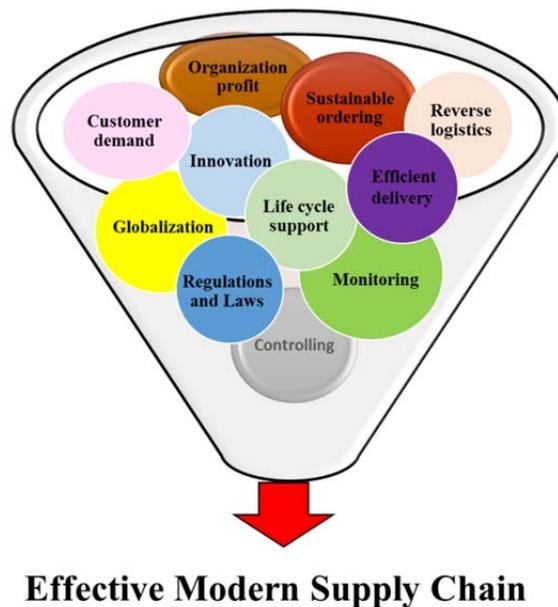
The Food Supply Chain is a highly integrated sector that is not immune from the product fraud vulnerability. Modern food supply chain management strategies cover all the aspects of food production to market and include manufacturers, suppliers, transporters, warehouses, retailers, customers, and even through disposition, destruction, or recycling. Such a systematic approach includes cross-collaboration between an interdisciplinary collaboration of experts in analytical science, predictive models, food safety, criminology, and business. While SCM is evolving, product fraud is also on the increase, especially with the development of information technology (IT) systems and ever more sophisticated methods of perpetrating product fraud. In an effective SCM, all elements of the system have the same importance. However, in the case of the food supply chain, the safety and integrity of the components in the food chain are essential and is critically valued. Food integrity is not only the state of being whole, entire, or undiminished or in perfect condition, in term of quantity and quality (hygienic, nutritive, sensorial), but also captures other aspects of food production, such as the way it has been sourced, procured and distributed and being honest about those elements to consumers (HM Government, 2014). A simple product fraud attempt in only one single step of the supply chain, e.g., production or distribution, could lead to public health harm. Adulteration of paprika and other spices with Sudan Red carcinogen colorant, and the addition of Melamine in infant formula are among these fraud examples. Different incidents were found to be related to an ineffective monitoring and scrutiny

controls within the long supply chains. Figure 2 illustrates an overall vision of fundamental components of the modern SCM (Hult et al., 2013).

To effectively manage the risk of product fraud within a supply chain, e.g., food supply chain, modern SCM strategies may be enhanced if they are:

- Receptive to customer demand and organization profitability;
- Responsive to sustainable order and delivery;
- Flexible to reverse logistics;
- Impulsive to launch new products and services taking into account life-cycle support;
- Connected to outsource activities and operations to outbound countries or areas;
- Linked to regulators and enforcement entities;
- Diligent in implementing appropriate and multifaceted monitoring and control systems.

Figure 2. The Effective Modern Supply Chain (Modified version from Hult et al., 2013)



Supply Chain Management is a specific scientific field of study that includes a structured method to assess the key components and optimize the movement of goods. Before considering the role of SCM in food fraud prevention it is important to review the definition and scope of food fraud, the focus on prevention, and the process to focus on reducing the fraud opportunity.

Food Fraud and the Focus on Prevention

Food Fraud – including the sub-category of the US Food and Drug Administration defined Economically Motivated Adulteration, EMA – is one of the most urgent food industry issues which are getting the attention of industry, governments, and researchers (Spink and Moyer, 2011). The scope includes all

types of fraud (from adulterant substances to stolen goods and intellectual property rights counterfeiting) and for all products (from raw ingredients through consumer packaged goods in the marketplace). The types of food fraud are presented and include dilution, substitution, concealment, unapproved enhancements, mislabeling/ misbranding, gray market sales, unauthorized production, theft, diversion and smuggling, and intellectual property rights counterfeiting (GFSI, 2018) (Table 1).

Table 1. Food Fraud Types, Definitions, and Examples [(GFSI, 2018) adapted from (Spink and Moyer 2011, Spink 2013, SSAFE Organization 2015, PWC PriceWaterhouseCooper 2016, GFSI 2017, Spink, Ortega, et al. 2017)]

GFSI (1) Type of Food Fraud	Definition from SSAFE (2)	Examples from GFSI FFTT (3)	General Type of Food Fraud
Dilution	The process of mixing a liquid ingredient with high value with a liquid of lower value.	<ul style="list-style-type: none"> Watered down products using non-potable / unsafe water Olive oil diluted with potentially toxic tea tree oil 	Adulterant-substance (Adulterant)
Substitution	The process of replacing an ingredient or part of the product of high value with another ingredient or part of the product of lower value.	<ul style="list-style-type: none"> Sunflower oil partially substituted with mineral oil Hydrolyzed leather protein in milk 	Adulterant-substance or Tampering
Concealment	The process of hiding the low quality of food ingredients or product.	<ul style="list-style-type: none"> Poultry injected with hormones to conceal disease Harmful food colouring applied to fresh fruit to cover defects 	Adulterant-substance or Tampering
Unapproved enhancements	The process of adding unknown and undeclared materials to food products in order to enhance their quality attributes.	<ul style="list-style-type: none"> Melamine added to enhance protein value Use of unauthorized additives (Sudan dyes in spices) 	Adulterant-substance or Tampering
Mislabelling/ Misbranding	The process of placing false claims on packaging for economic gain.	<ul style="list-style-type: none"> Expiry, provenance (unsafe origin) Toxic Japanese star anise labeled as Chinese star anise Mislabeled recycled cooking oil 	Tampering
Grey market production/ theft/diversion	Outside scope of SSAFE tool.	<ul style="list-style-type: none"> Sale of excess unreported product, Product allocated for the US market appearing in Korea 	Over-run, Theft, or Diversion (4)
Counterfeiting (IPR)	The process of copying the brand name, packaging concept, recipe, processing method, etc. of food products for economic gain.	<ul style="list-style-type: none"> Copies of popular foods not produced with acceptable safety assurances Counterfeit chocolate bars 	Counterfeiting (IPR)

Notes: (1) GFSI – Global Food Safety Initiative; (2) SSAFE – Safe Secure and Affordable Food For Everyone; (3) GFSI FFTT – Global Food Safety Initiative: Food Fraud Think Tank; (4): Gray Market -- a market employing irregular but not illegal methods; Theft -- something stolen; Diversion/ Parallel Trade -- the act or an instance of diverting straying from a course, activity, or use

Food fraud is one type of a food risk that is presented in the Food Risk Matrix (Fig. 3). The food risks are separated into categories of intentional and unintentional acts, and then the intentional acts are separated into motivation including economic gain or harm (e.g., public health, economic harm, or terror). Addressing all types of food fraud for all types of products is important for an entity to address all types of food risks holistically.

		Motivation
Food Quality	Food Fraud (1)	Gain : Economic
Food Safety	Food Defense	Harm: Public Health, Economic, or Terror
Unintentional	Intentional	
Action		
<small>(1) Includes the subcategory of economically motivated adulteration and food counterfeiting</small>		

Figure 3. Food Risk Matrix: a hierarchy of risks including food quality, food safety, food fraud, and food defense (Spink and Moyer, 2011)

In the food safety field, there is a saying *we cannot test our way to safety*. While testing and detection are important, there is a focus on prevention and reducing the situations where a health hazard could happen. This prevention is achieved by focusing mainly on microbiology and toxicology. For food fraud, *we cannot arrest or authenticate our way to prevention*. While being able to detect and authenticate product are important, there is a focus on reducing the situations or vulnerabilities in the supply chain. The prevention is also achieved by utilizing control systems and traceability. Following the same idea, for food fraud, *we cannot track or electronically authenticate our way to prevention*.ⁱⁱ While being able to track and electronically authenticate product is important, they are tactics that play a role in reducing the fraud opportunity. This vulnerability reduction is achieved by focusing mainly on the root-cause which is the human adversary so social science and criminology (Spink et al., 2016a,b,c; Fortin et al., 2016).

Finally, after reviewing the basics of Supply Chain Management and then the overall Food Fraud concepts as well as the focus on prevention, now a review can be conducted of the role of Supply Chain Management in Food Fraud Prevention.

Combining Supply Chain Management and Food Fraud Prevention

Considering the holistic and all-encompassing focus on all types of food fraud for all products, the “Food Supply Chain Vulnerabilities” occur anywhere in the entire marketplace (Spink, 2014) (Figure 4).

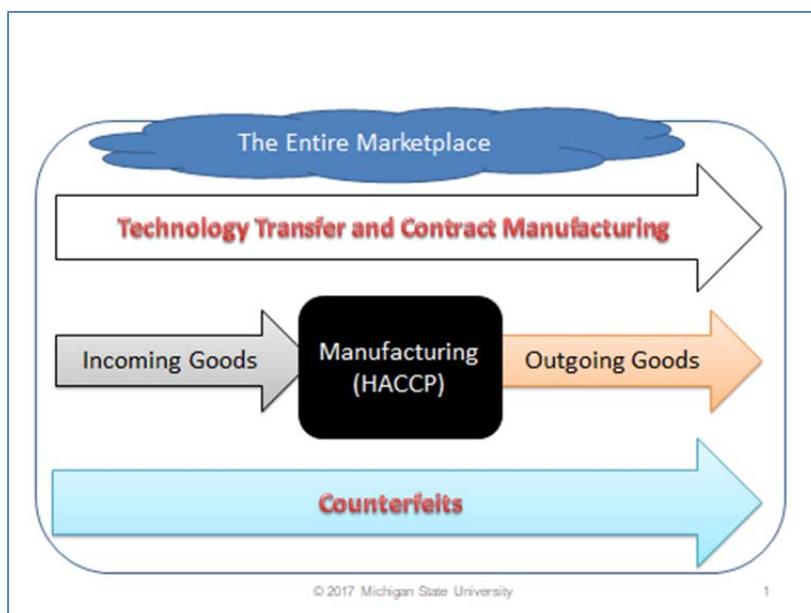


Figure 4. The Food Supply Chain Vulnerabilities (Spink and Moyer, 2011)

The risks may occur within the legitimate and authorized networks as well as outside in the illegal or illegitimate markets. These are all food fraud risks since any product, anywhere, could lead to public health harms or to a global recall. Traditional business manufacturing operations focus on the legitimate and proprietary supply chain including raw ingredients, incoming goods, in-process manufacturing, distribution of finished goods to the consumer, and even the final disposal of the product and packaging. A part of the legitimate supply chain that is often somewhat monitored by the brand owner or manufacturers is for technology transfer (e.g., licensing) and contract manufacturing. Others parts of the corporation, such as Corporate Security, often monitor other areas outside the legitimate or authorized supply chains including counterfeits, stolen goods, or other diverted products.

The Role of Supply Chain Management in Food Fraud Prevention

Since the fraudsters are opportunistic and seek opportunities at any point in the supply chain – and could conduct any type of fraud – the entire supply chain must be assessed for vulnerabilities and included in a holistic prevention strategy. The entire supply chain includes product within the proprietary, authorized, legitimate supply chain both before and after manufacturing through to the consumer and even to disposal. All types of fraud includes products manufactured and controlled by the entity as well as technology transfer or licensing with else oversight and even counterfeits or illegal product that never enter the legitimate supply chain. By taking a holistic and all-encompassing focus on the entire supply chain and all types of fraud then the countermeasures and control systems can address the entire fraud opportunity.

Conclusion

The emerging and evolving Food Fraud vulnerabilities have led to more formal and rigorous methods to review the root cause, consider the decision-making, and then to implement standardized and optimized prevention strategies. A key component of the interdisciplinary approach is the supply chain vulnerabilities. The Supply Chain Management (SCM) science provides a structured, methodical, and professional set of theories that are integrated with other business management and decision-making systems. Based on SCM theory, and focused on reducing the fraud opportunity to support a Food Fraud Prevention Strategy, the movement of goods can become more secure for both the product leaking out of or entering the supply chain. Effective supply chain management requires transparency, traceability, and data sharing among industry, government, and third-party organizations worldwide. The combination of an end-to-end logistics and supply chain operations, track and trace strategies and effective data elaboration could reduce opportunities for fraudsters to penetrate the supply chain.

About the Authors

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Biographies

Bahar Aliakbarian is Research Associate Professor at the Axia Institute within the Department of Supply Chain Management and Adjunct Associate Professor at the School of Packaging at Michigan State University. Dr. Aliakbarian received her Ph.D. in Chemical, Material and Process Engineering from the University of Genoa (Italy). Her multidisciplinary research experiences focus on the integration of innovative engineering technologies which has led to the formulation of new products with food and biomedical applications. This research focuses on environmentally-friendly strategies to develop value-added products from the scrap generated in the processing plants and along the food supply chain. Dr. Aliakbarian's work has broadened to the development of active and smart packaging for food and pharmaceutical applications. She is particularly interested in the use of smart technologies to track and monitor food and pharmaceuticals along the supply chain. She has more than 70 peer-reviewed articles in refereed journals and more than 40 peer-reviewed conference proceedings. She has a strong international scientific network collaboration. She had prestigious postdoctoral awards and fellowships and worked at the MIT-Harvard Medical School, The University of Sydney (Australia), the Université de Lorraine (France) and University of Genoa (Italy).

John Spink has been the Director of the Food Fraud Initiative within the College of Veterinary Medicine at Michigan State University (USA). Food Fraud Initiative is an interdisciplinary activity focused on detecting and deterring this public health and economic threat. The research focus is on policy and strategy starting with Criminology and through the application of business decision-making and COSO/ Enterprise Risk Management. His leadership positions include product fraud-related activities with "ISO 22000 Food Safety" and "TC292 Security Management/ Fraud Countermeasure," WHO, FAO/UN, GFSI Food Fraud Think Tank, and U.S. Pharmacopeia (USP). Global activities include engagements with the European Commission, INTERPOL/ Europol Operation Opson, New Zealand MPI, Codex Alimentarius, WHO/FAO, and served as Advisor on Food Fraud to the Chinese National Center for Food Safety Risk Assessment (CFSA). Previously he was an Assistant Professor in the School of Criminal Justice in the College of Social Science at MSU. His 2009 Packaging Ph.D. research, within the College of Agriculture and Natural Resources at MSU, was on Anti-Counterfeit Strategy. While conducting his research and outreach, he has a full teaching load with graduate courses such as Packaging for Food Safety, Anti-Counterfeiting, and Product Protection, Quantifying Food Risk, and Food Fraud Prevention. He is widely published in leading academic journals with important works such as "Defining the Public Health Threat of Food Fraud," "Defining the Types of Counterfeiters, Counterfeiting, and Offender Organizations," and "Introduction of the Food Fraud Initial Screening Method (FFIS)." Before returning to Academia in 2009, he worked for over 11 years at Chevron Corporation and 3 years in general management consulting. Outreach includes a series of food-related free, online courses presented in a MOOC (free, Massive Open Online Course) format. Please see www.FoodFraud.msu.edu

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MSU's Food Fraud Initiative will continue to inform global stakeholders as to the relationship between Food Fraud and Economically Motivated Adulteration, Food Crime, Food Integrity, and Food Authenticity in order to encourage a global set of terms and definitions that are consistent.

Note: MSU's Food Fraud Initiative (FFI) conducts a wide range of teaching, research and outreach projects. The "FFI Report" series was created to review specific emerging topics or recent laws, regulations, certifications, standards, or best practices. The summary and insight is not legal advice and is not intended to replace the counsel of a food law expert.

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ⁱ The concept of Supply Chain Security that is protecting the supply chain from attack or harm should not be confused with the Food Security term that is the safe, continuous, nutritious, and economic supply of food. The food industry refers to protecting the food supply from intentional acts of harm as Food Defense.

ⁱⁱ Note: Food Authenticity usually refers to product testing to confirm attributes of a material good (CODEX 2017; HM DEFRA, 2014). Electronic authentication or an authentication feature usually refers to a physical feature added to a package that allows confirmation of information. Specifically, an authentication method (ISO TC292) is the process of identity authentication using one or more authentication factors (ISO/IEC TR 29156:2015). Also, an authentication solution (ISO TC292): complete set of means and procedures that allows the authentication of a material good to be performed (ISO 12931:2012)