

Managing Food Quality Risk in Global Supply Chain: A Risk Management Framework

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Abstract Today, the food sector is one of the sectors most vulnerable to intentional contamination by debilitating agents [1]. Some cases of contaminated food have indicated that product quality risk is one of the vulnerabilities in the global supply chain. A series of company scandals, affecting reputation and causing the recall of products and increasing costs have hit the food industry. The obvious problem is that even a minor incident in one part of the chain can have disastrous effects on other parts of the supply chain. Thus, risks are transmitted through the chain. Even though the dangers from members in the supply chain are small, the cumulative effect becomes significant. The aim of this study is to propose an integrated supply chain risk management framework for practitioners that can provide directions for how to evaluate food quality risk in the global supply chain. For validating the proposed model in-depth, a case study is conducted on a food SME distributor in Central America. The case study investigates how product quality risks are handled according to the proposed framework.

Keywords Supply chain risk; Risk management; Risk Assessment; Case Study

1. Introduction

Consumers are finding that brands do not guarantee safety. In recent years, the number of cases of contaminated food has increased and product recalls have flourished. For instance, during the melamine milk incident in mainland China, babies were being poisoned by the Sanlu's contaminated milk [2]; Sausages, pizzas and ready-meals containing Irish pork ingredients were contaminated by dioxin, since the pigs were fed with contaminated animal foods; and the Peanut Corporation of America distributed contaminated peanut butter that was used in hundreds of different products in United States industries. Another example concerns John West canned salmon, which produced a toxin that caused deaths in 1978 in the UK; with Farley's baby food it was found out that contamination occurred after the milk had been heat-treated and before it had been packed; also, in 1982 seven people died in Chicago after taking Extra-Strength Tylenol capsules [3]. The cost of these recalls was estimated in the millions of dollars. It is estimated that up to 81 million cases of food-borne illness occur each year, resulting in 10,000 deaths [4]. In light of this, the management of food safety risks in a multi-tier

supply chain is vital for firms' costs and consumers' health and safety.

Given the complexity of the global supply chain, one member or a single group cannot remove all of the food safety risks that are rapidly increasing due to the increased volume of importing activity. The global sourcing and outsourcing of products has increased with the opening up of markets. Globalisation and the fast improvement in high quality products have brought high levels of market pressure to companies. The number of global sourcing providers of food and ingredients is growing fast. Consequently, the number of entities involved in the supply chain network is increasing, making supply chain quality management very difficult.

The product quality risk (PQR), as a concept, has not been fully researched. Thus, the purpose of this study is to present an integrated conceptual framework to identify and effectively assess the quality risk of a product along the global supply chain. For validating the proposed model, a case study is conducted on a food SME distributor in Central America. The research objectives include:

- The development of a conceptual Product Quality Risk Management framework for self-evaluating supply chain quality risks in a firm.
- Conducting a case study for validating the proposed supply chain quality risk management framework.

The structure of this paper is as follows: In section 2, it describes the research model of supply chain risk management. Section 3 provides the case study and discussion section. The paper ends with a discussion of the results in terms of their theoretical and practical implications, and sums up the research findings.

2. Product Quality Risk Management

2.1 Product quality risk in global supply chain

The recent incidents involving products have raised public awareness of the global supply chain. The food market, for instance, is increasingly demanding regulation for food safety [5]. All of the members of the supply chain are focusing their energy on inspections. The ISO standards and HACCP system apply to the food industry but food borne illnesses continue to occur; these methods are limited and do not provide an effective procedure for managing Food Quality Risk in the Global Supply Chain. For instance, the ISO series standard does not guarantee a functional quality performance system in the supply chain [6,7,8]. Sroufe and Curkovic [8] have pointed out that the bureaucratic process and documentation makes it hard to perceive the real benefits from the ISO series. Moreover, the ISO 9000 series is not

linked directly to a product's quality [8,9]. Companies have been dealing with this problem by employing numerous solutions, such as tracking systems, lot identification numbers and explicit procedures for returning or destroying goods [10]. However, these strategies alone will not be sustainable or effective in ensuring product quality over the long term.

In the existing literature, the concepts of quality, risk and the global supply chain have been investigated separately. Since product recall has increased over recent years, the Product Quality Risk (PQR) in the concept of the global supply chain concept has flourished. Today PQR remains an issue that has not been fully researched. The PQR in the supply chain focuses on problems of quality in the multi-tier supplier context rather than from the perspective of manufacturing quality. Thus, the PQR in supply chain can be defined as:

a product's quality state in which it is affected by direct and indirect multi-tier suppliers' materials, in which a minor risk incident can have a cumulative effect along the whole network.

This research consolidates the major supply chain risk management models [10,11,12] provided by the literature and offers an integrated framework. The framework provides a strategic view of quality risk management in reducing quality risk from three major perspectives: the supplier, the focal firm and the customer (see figure 1). The proposed framework also provides a strategy for solving the main problems associated with sustainability.

2.2 Customers' focus - the desired quality

This identifies the characteristics of quality that are relevant to an actor who acquires a product. In order to achieve the desired quality, Bozarth and Handfield [10] developed a four point framework to achieve it. The product quality evaluation should follow a descendent order as it is explained, before the quality management framework section, starting with an understanding of customers' quality dimensions etc.

Bozarth and Handfield [10] affirmed that quality can be defined according to the perspective of value and conformance. Quality is defined as the "product or service characteristics that bear on its ability to satisfy stated or implied needs;" in other words, a product or service is free of defects. The value perspective relates to how well the product's features are connected with customers' needs. Some other scholars have taken another, similar concept of quality: Juran [13] defined it as "fitness for use;" Garvin [14] proposed eight dimensions to evaluate the quality of a product.

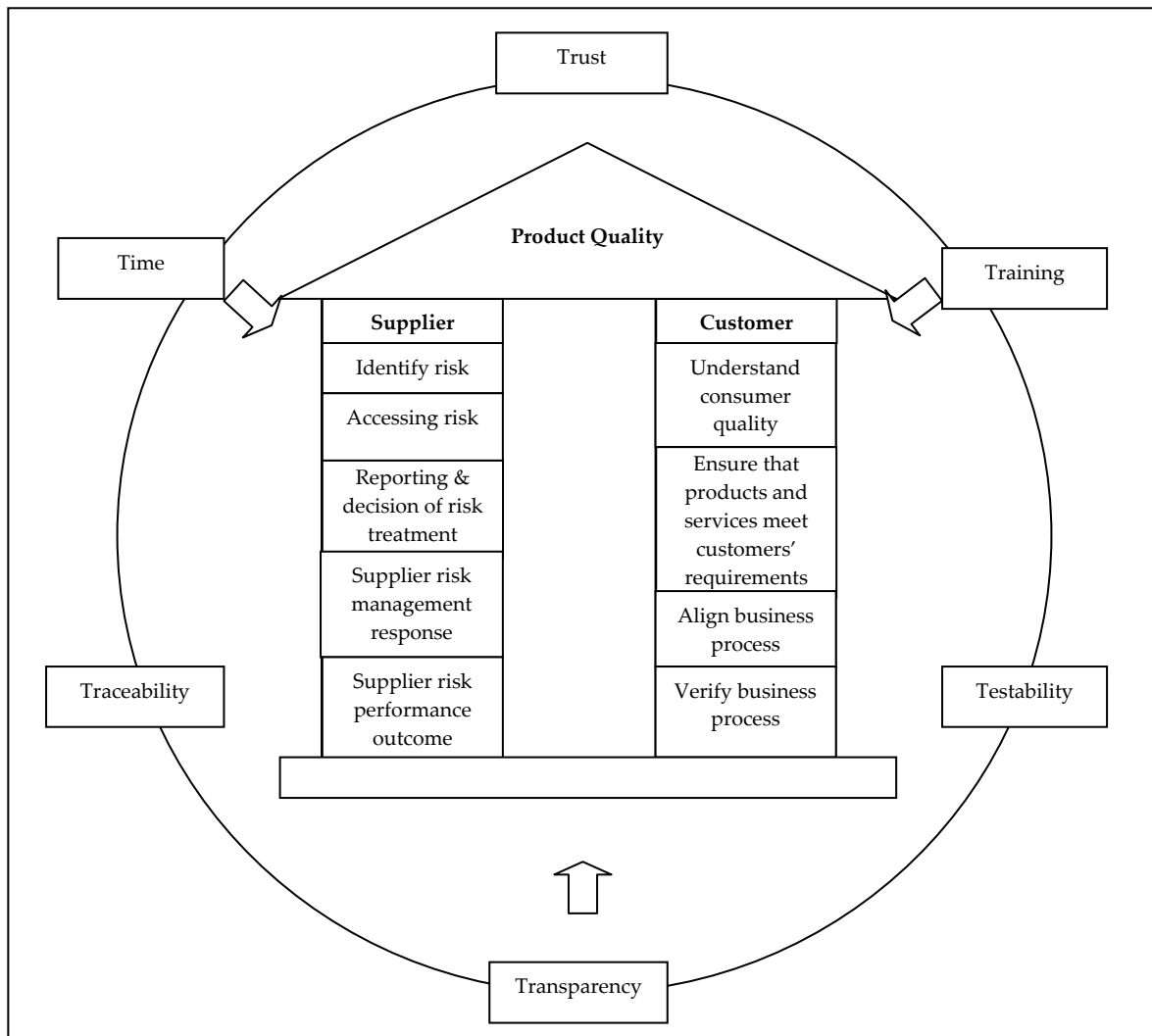


Figure 1. The proposed supply chain quality risk management framework

For the conformance perspective, quality refers to whether or not a product was made. It is usually evaluated by measuring the actual product against some pre-established standards. Thus, Bozarth and Hadfield [10] suggested four key points to achieve high quality products and services for customers, namely:

- (i) Understand the most important quality dimensions for customers.
- (ii) Develop products or services that meet customer's requirements.
- (iii) Align effective business processes to meet the specifications driven by customers' requirements.
- (iv) Verify that the business processes are meeting their specifications.

Note that these evaluations will vary from one customer to another.

2.3 Suppliers' focus - supplier risk management

This evaluates suppliers' risks in the multi-tier supply chain. For Matook et al. [11]'s supplier risk management,

a five stage framework is proposed so as to improve the entire risk management process; it can be initiated at different stages simultaneously, depending on the risks confronting a company.

Matook et al. [11]'s supplier risk management framework aims to improve the entire risk management process through a sequential form of five stages. The framework "is [a] more dynamic, agile, and responsive process, which supports loops, bypassing of stages, and other fallbacks in the process." This framework is based on two main structures, which consist of (i) Ritchie and Brindley's [15] risk management framework, which explores the connections between risk and performance for a company, and (ii) the supplier risk management framework proposed by the Association of Insurance and Risk Managers [16].

The five steps of supplier risk management are described below:

- (i) *The first stage is related to the identification of risk.* In order to succeed in the management of the risk, it is

crucial to identify the risk types and drivers that make the supply chain vulnerable. Companies need to decide which risks are relevant in practice to the core product. Moreover, the company must select the group of suppliers which will be assessed.

- (ii) *In the second stage, the assessment of the supplier and the relevant risks are calculated.* Different risk types and risk drivers are measured. The proposed approach is a “two-sided perspective” rating mechanism. This means an internal and external perspective related to one supplier. The company must internally evaluate the supplier and the supplier in turn must evaluate themselves. The benefit of this “two-sided” approach allows the manager to explore differences in opinions and so create a richer view of the risk [17].
- (iii) *The third stage involves the reporting and decisions concerning supplier data.* This is a step which refers to the integration, representation and classification of the data. A reduced number of risk types are preferred. Therefore, the multivariate analysis procedures are more suitable, especially the exploratory factor analysis which reduces the risks in categories [18].
- (iv) *The fourth stage is concerned with the management of the supplier risk results.* A list of risk treatment plans is required to improve suppliers’ performance quality. The benchmark approach is a technique which utilises supplier development. It constitutes a continuous improvement process in relation to quality and performance [19]. Indeed, this method will focus on searching for the “best practice” and recognize others’ processes and product advancements [20].

2.4. The six Ts - drivers of supply chain risk management

We adopted the concept of six Ts from Roth et al. [12]’s supply chain quality management framework, which is applicable to any supply chain member. These six Ts are critically associated with product quality. In order to achieve the best practices for the managing supply chain risk process, in our integrated framework the six Ts are interpreted as the six important drivers in the risk management process:

- (i) Traceability is the ability to track a physical product’s flow towards the production process and supply chain.
- (ii) Transparency refers to the availability of the relevant product and process information of products/materials. It also extends to the concept of information visibility while the product is transformed from the material in each supply chain entity.
- (iii) Testability is related to the ability to detect defects in products. Primarily, there are two vital factors directly affecting testability: (a) the complication

of the product structure, and (b) the long testing time of the quality dimension.

- (iv) Time is the duration of a particular process, including the order lead time, the production lead time and the logistics lead time.
- (v) Trust is concerned with the expectation that parties will behave according to their acquired commitments.
- (vi) Training is the process of improving awareness about international standards of quality, safety and best practice.

3. Case study

The case study research method permits a view of real world events. This technique aims to explore areas in which theoretical data is limited or just at its early stages [21]. Perry [22] claimed that a case study approach is the most useful and appropriated method for examining research problems. The challenge in using a case study is to separate the important data from the irrelevant. The researcher is actively involved in the convergence of the information to be used to answer the research question.

Case studies are exposed to a number of criticisms relating to their natural scientific design. According to Yin [21], a case study should have a clear design before any data is collected.

The case company adopted the proposed risk management framework to “read” their company’s quality risk. However, the proposed risk management framework is not a tool for mitigating risk - it is a process which provides specific insights and exposes the risk-related issues hidden in the supply chain.

With the assistance of a risk management framework, the company manager could examine the risk quality from both suppliers’ and customers’ perspectives, and so gain a specific insight as to the risk in their global food supply chain.

3.1. Case company background

A Central America SME – *El Mundo* (the real name has been not been used for security reasons) - was preferred rather than a large one since SME is easier to investigate with regards to the complex process of managing product quality risk through the global supply chain. In addition, SMEs represent a major aspect of market income in Central America. Moreover, *El Mundo* is one of the leading distributors, supplying their imported products to most of the Central American regional market.

There are about 45 employees in *El Mundo*. It distributes popular products with a high volume, and its major supply base includes 12 first-tier suppliers, which are

mainly located in America. More than half of the first-tier suppliers are large firms and they are mostly located in Mexico.

The company relies greatly on importing, 100 per cent of its products comes from international suppliers. For example, one of the key foreign suppliers of diapers and pellets is located in the United States and Mexico.

The major service of *El Mundo* lies in importing products and distributing them to customers, mostly in the local market. Moreover, the company also has several customers, from Guatemala and Honduras, which includes retailers, wholesalers and department stores (e.g., Wal-Mart).

In this case study, both the CEO and the purchasing director of *El Mundo* were interviewed, and video-conference interviews were conducted with 12 direct suppliers.

3.2. Adopting a risk management framework in evaluating a firm's global supply chain

The collection of accurate information related to the product quality risk was complex and required analysis and research through innovative interview and questionnaire techniques. The PQR framework in the global supply chain has consistently offered the most up-to-date and relevant information for building a PQR risk strategy programme. It offers a wide variety of PQR's details and tools to assess the risk along the supply chain network. This framework was completed in 2 months and it required the participation of the whole organisation structure's members. In order to understand this framework, the following sections should be explored.

3.2.1. Customers' focus - the desired quality

The quality dimensions of the *El Mundo* customer include such general features as reliability, durability, conformance and quality. The company offers the following products: cereals, pallets, diapers, candies, baby bottles, mayonnaise, baby wipes, sanitary towels, cloth hangers and marshmallows, which are targeted to fulfil customers' requirements. However, the company does not have any clear process capable of meeting the specifications required by customers. Current processes do not provide very formal quality controls or feedback according to customers' requirements.

3.2.2. Suppliers' focus - supplier risk management

The company decided which risks are relevant in practice to the core business. In addition, the company determined that all 12 of its suppliers should be assessed. Based on interviews with the suppliers, four major quality-related risks were identified. These risk types and their risk drivers are shown in the table below.

Risk dimension	Description
Quality Risk	Poor quality control during the production process.
Price Risk	Cutting the prices of suppliers by using lower grade materials.
Technology Risk	Poor technology in the quality inspection facility.
Environmental Risk	Contamination may occur due to the poor environments involved in storage and transportation.

Table 1. Risk dimensions in sub-tier suppliers

A benchmarking team including the company's directors and supplier partners was organised in order to reduce the product quality risk based on the risks identified. Both parties have to make contracts of commitment. This group should define action plans for different periods of time and provide clear paths to improve the management of product quality through the supply chain. The purchasing director has terminated some suppliers' relationships where there were high risks.

3.2.3. The six Ts' risk management driver

Traceability

Even though the tracking of goods is relatively simple from the producer through to the distributor, the tracing process for goods all the way back to the source is extremely difficult for the distributor company because of the cost and the lack of well-established facilities in the system. In addition, government traceability requirements, such as taxes and container customs checks, make the flow of goods in the system very slow. Currently, tracing the entire path of goods from the manufacturer to grocery store shelves is effectively impossible.

Transparency

The goods supply chain's transparency is relatively low for this company because it has lack of visibility in the supplier production process. This means that the company does not have any information about its supplier's sources or production practices. The company maintains physical transparency in its documents, information and goods with the main suppliers.

Testability

According to *EL Mundo's* purchasing manager, "it is impossible to test 100 per cent of the arriving products." For instance, the cereal is imported in a 40' HQ container (full) in bulk, which makes it very difficult to test it. There is a risk in detecting contaminated food through the transportation and unloading process. At the moment, the company implemented the 10 rules as a quality test policy, in which 10 per cent of the unloaded product is checked.

Time

The role of time can be evaluated from different perspectives and has an impact on both short- and long-term performance. The time between the discovery and the reporting of product quality problems takes approximately 1 month. It is based on the experience of the past recall of cereal and diapers products. The time for recovery from product recall disruptions is around 3 weeks, based on one of the most difficult problems that the company had with the custom agency.

Trust

In the food industry, one strategy for safeguarding quality is investment in long-term relationships with honest suppliers. The company has a strong relationship with their suppliers which allow them to cooperate and develop bonds of trust. The company's owners had visited the suppliers' processing plants.

Training

The company receives annual technical assistance with its processes. This means that the company contracts an external organisation which inspects, evaluates and implements new companies' practices in order to improve the flow of goods and information. At the moment, the company is not actually interested in any training in relation to its product portfolio or its regional expansion. Ensuring the safety of food products along the supply chain has provided a challenge to the company when it had product recalls.

4. Discussion

EL Mundo's managers were very impressed with the proposed product quality risk management framework. The benefits included:

- (i) Detailed and accurate customer information being available. According to the CEO's comment, "with the application of the framework the company will be aware of customer desires and the product selection will be more accurate."
- (ii) Providing support against the critical challenges in relation to the global food supply. The framework presents research themes in product tracking systems, transparency, quality controls programs, the reduction of the product transit time, trust relationships and constant quality training.
- (iii) Simplifying the identification and communication of the risks associated with organizational structure. The Logistics Manager pointed out that "It is easy to identify what are the risks that the company is currently facing."
- (iv) A method for evaluating the risk of multi-tier suppliers' networks.

- (v) Providing information to organise action plans so as to increase the flexibility of manageable quality products.
- (vi) Encouraging predictable, secure standards and best practices, with maintainable and reliable principles.

However, there are several limitations in implementing the model, which are:

- (i) Given the diversity of supply chain agents, it may be that the application of this framework cannot be made in all cases because each supplier's members will have different purposes. It is a general, conceptual framework.
- (ii) The application of the framework required reliable data collection methods.
- (iii) The full participation of the organisational structure's members. In the view of the CEO, "sometimes [it] is complicate[d] to explain to the supplier why it so important to collected this data."
- (iv) Requiring a commitment from the whole multi-tier supply chain network.
- (v) Requiring the availability of information and the company's documents.
- (vi) The availability of time - the purchasing manager commented that "in order to apply the entire framework, two months were required."

5. Conclusion

Globalisation and the fast improvement in high quality products have brought high levels of market pressure to companies. The global sourcing providers of food and ingredients are growing fast. Consequently, the number of agents involved in the supply chain network has increased, making supply chain quality management very difficult. For this reason, companies have more delay points and greater uncertainties. Today, greater coordination, communication and monitoring are required of firms. The obvious problem is that even a minor incident in one part of a supply chain can have disastrous effects on other parts of the supply chain network. As such, suppliers are providing components (or materials) that do not meet quality specifications. A series of company scandals, losses of reputation and product recalls and high costs are hitting the food industry.

Companies are being forced to modify their old operations' management methods and develop better systems to guarantee that customers are satisfied with products.

The concept of food quality risk has not been deeply investigated, especially in relation to the product quality risks along the supply chain network. PQR in the supply chain is the focus on the quality problems in the context of the multi-tier supplier, in which a minor incident can have a cumulative effect along the whole network.

Even though there are many risk management options which aim to reduce risk, it should be noted that there is no framework that proposes an accurate approach in which all of the members work together to mitigate the effects of these risks. Matook et al. [11] proposed a supplier risk management framework which aims to improve the entire risk management process through a sequential form of 5 stages. However, this approach focuses on suppliers' risks in general without consideration of product quality.

There are many concepts of quality, depending on the actor who acquires the product along the supply chain. Bozarth and Handfield [10] affirmed this and proposed that quality can be defined according to the value and conformance perspective. Thus, they suggested four points to bring high-quality products and services for customers.

Roth et al. [12] proposed a conceptual framework for supply chain quality management called the "six Ts," namely traceability, transparency, testability, time, trust and training. According to them, it can be applied to any supply chain. These six Ts are critically associated with product quality.

In order to assess PQR, a case study has been employed. The case study was carried out on a Central American food product distributor, *EL Mundo*. The data was collected by using interviews and questionnaire approaches. The semi-structured interview aimed to identify the most relevant risk types and drivers along the supply chain.

During the adoption of the risk management framework, the company's issues related with the risk to quality along a multi-tier network were exposed, and action plans were proposed. However, the proposed risk management framework is not a tool for mitigating the risk - rather, it is a process which provides for and exposes all the issues related with product quality risk. As a result, the exposure of organisational incidents should be reduced in the near future. The application of quantitative methods to measure the quality risk should be considered as a topic for further research. The analysis of the case study was complicated, since it was made in a different country and did not include a visit to the company visit during the time of evaluation. Due to information delays in the interviews and surveys, it proved to be very hard to complete the data collection process.

The analysis of the case is limited, since it was only used to examine the risk management framework. The outcome would be more interesting if the proposed framework were applied to more cases studies.

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