

Managing food quality risk in global supply chain: A risk management framework

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Resumen

Hoy en día, el sector de alimentos es uno de los más vulnerables a la contaminación intencional o espontáneo de agentes contaminantes. Algunos casos de alimentos contaminados han indicado que el riesgo de la calidad del producto es uno de los puntos más vulnerables en la cadena de suministro global.

Escándalos recientes de productos contaminados han provocado el retiro de productos del mercado (Recall), repercutiendo en altos costos que afectan a la industria de alimentos. El problema evidente es que incluso un incidente menor en alguna parte de la cadena de suministro puede tener efectos desastrosos en otras partes. A pesar de que los riesgos individuales de cada una de las entidades en la cadena de suministro son pequeños, el efecto acumulativo puede llegar a ser significativo.

Actualmente, los conceptos de calidad, riesgo y cadena de suministro global se han investigado separadamente. El concepto de riesgo de la calidad

del producto a través de la cadena de suministro no ha sido totalmente investigado.

El objetivo de este estudio es proponer un marco teórico de gestión del riesgo para evaluar la calidad de los productos a través de la cadena de suministro. Para validar el modelo propuesto, un estudio de caso se llevó a cabo en una distribuidora de alimentos, PYME en Centro América. El caso de estudio describe cómo los riesgos de calidad del producto se manejan y cómo la aplicación del marco teórico permitió exponer a varios niveles los riesgos relacionados con la calidad del producto en la cadena de suministro.

Palabras clave: Riesgo de la cadena de suministro, Gestión de Riesgos, Evaluación de Riesgo, y Caso de Estudio.

Abstract

Today, food sector is one of the most vulnerable sectors to intentional contamination by debilitating agents [1]. Some cases of contaminated food have indicated that product quality risk is one of the vulnerabilities in global supply chain. A series of company scandals, reputation and recall products

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and costs are hitting the food industry. The clear problem is that even a minor incident in one part of the chain can have disastrous effects in 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 the practitioners that it provides direction of how to evaluate food quality risk in the global supply chain. For validating the proposed model in-depth, a case study is conducted in a food SME distributor in Central America. The case study investigates how the product quality risks are handled according to the proposed framework.

Key words: *Supply chain risk; Risk management; Risk Assessment; Case Study*

Introduction

Consumer is finding that brand does not guarantee safety. In recent years, some cases of contaminated food have increased and product recall has flourished. For instance, the melamine milk incident in mainland China, babies were being poisoned by the Sanlu's contaminated milk [2]; Sausage, pizza and ready meals contained Irish pork ingredients were contaminated by dioxin, since the pigs are fed by contaminated animal food; and Peanut Corporation of America distributes contaminated peanut butter that is used in hundreds of different products in the United States Industry. Another example was John West canned salmon which produced the toxin that caused deaths in 1978 in the UK; Farley's baby food that found out that contamination occurred after the milk had been heat-treated and before it was packed; and also, in 1982 seven people died in Chicago after taking Extra-Strength Tylenol capsules [3]. The cost of these recalls was estimated in 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 the light of this, manage food safety risks in a multi-tier supply chain is vital for firm's cost and consumer's health and safety.

At the complexity of global supply chain, one member or a single group cannot remove all the food

safety risks that are increasing rapidly due to the increased volume in importing activity. Global sourcing and outsourcing of products have increased with the opening of the markets. The globalisation and the fast improvement in high quality products have brought high level of market pressure to the companies. The global sourcing providers of food and ingredients are growing fast. Consequently, the number of entities involved in the supply chain network is increased, making supply chain quality management very difficult.

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

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

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

Product quality risk management

Product quality risk in global supply chain

This recent incidents in products have raised public awareness in the global supply chain. Food market, for instance, is increasing the demanding of regulation for food safety [5]. All the members of the supply chain are focusing their energy on inspections. The ISO standards and HACCP system are applying in food industry but food borne illness

is still occurring; these methods are limited and do not provided and effective procedure for managing Food Quality Risk in Global Supply Chain. For instance, ISO series standard does not guarantee a functional quality performance system in supply chain [6, 7, and 8]. Sroufe and Curkovic [8] pointed out that the bureaucratic process and documentation makes difficult to perceive real benefits from ISO series. Moreover, ISO 9000 series are not linked directly to product quality [8,9]. Companies have been dealing with this problem by employing many 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 to ensure product quality in a long term.

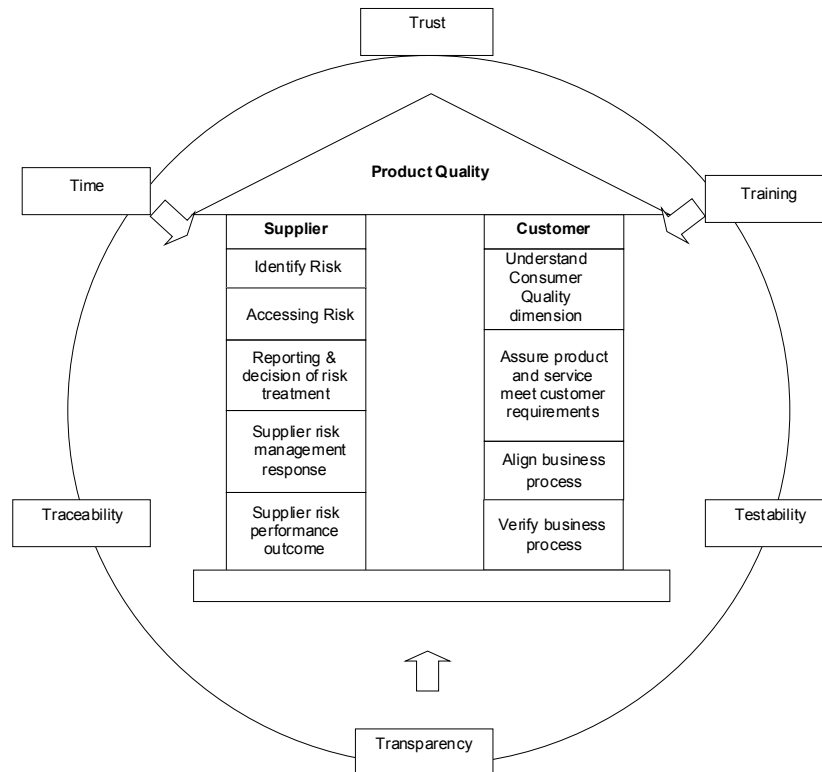
In existing literature, quality, risk and global supply chain concepts are separately investigated. Since the product recall has been increased in

the recent years, the Product Quality Risk (PQR) in Global supply chain concept has flourished. Today PQR is an issue that is not fully researched. PQR in supply chain is focus on the quality problems in the multi-tier supplier context more than in the manufacturing quality perspective. Thus, the PQR in supply chain can be defined as:

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

This research consolidated the major supply chain risk management models [10, 11, 12] in the literature and forms an integrated framework. The framework provide a strategic view of quality risk management in reducing quality risk in three major perspectives: supplier, focal firm and customer (see figure 1). The proposed framework also provides a strategy to solve the main problem with sustainability.

Figure 1. The proposed supply chain quality risk management framework



Source: Owm elaboration.

Customer's focus- the desired quality

It identifies the characteristics of quality that is relevant to the actor who is acquiring the product. In order to achieve the desired quality Bozarth and Handfield [10] developed four points framework to achieve it. The product quality evaluation should follow a descendent order as it is explained before in the quality management framework section, starting with understand customer's quality dimensions and so on.

Bozarth and Handfield [10] affirmed that quality can be defined according to the value and conformance perspective. 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 is how well the product's features are connected with the customer's needs. There are some other scholars take another similar concept of quality: Juran [13] defined as "fitness for use." Garvin [14] proposed eight dimensions to evaluate the quality of a product.

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 to customers which are:

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

Note that these evaluations will vary from one customer to the other.

Supplier's focus - supplier risk management

It evaluates the supplier risk in the multi-tier supply chain. The Matook et al. [11]'s supplier risk man-

agement five stage framework which is proposed to improve the entire risk management process; it can be initiated at different stages simultaneously depending on company's facing risks.

Matook et al. [11]'s supplier risk management framework which aims to improve the entire risk management process through sequential form of five stages. The framework "is 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 consists 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 Association of Insurance and Risk Managers [16].

The five steps of the supplier risk management are described as below:

- (i) *The first stage is related with the identification of risk.* In order to succeed on the management of the risk is critical to identify the risk types and drivers that make vulnerable the supply chain. The 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 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 internally has to evaluate the supplier and the supplier in turn has to evaluate himself. This benefit of this "two-side" approach allows the manager to explore the differences in opinions and to create a richer view of the risk [17].
- (iii) *The third stage is reporting and decision of supplier data.* This is a step refer to integration, representation and classification of the data. A reduced number of risk types are preferred. Therefore, the multivariate analysis procedures are more suitable, special the exploratory factor analysis which reduces the risks in categories [18].

- (iv) *The fourth stage is concerned to manage of the supplier risk results.* A list of risk treatment plan is required to improve supplier's quality performance. The benchmarking approach is a technique which utilises supplier development. It is a continuous improvement process in quality and performance [19]. Indeed, this method will focus on searching the "best practice" and recognize others process and product advancements [20].

Six T's drivers of supply chain risk management

It was adopted the six T's concept from Roth *et al.* [12] 's supply chain quality management framework which is applicable to any supply chain member. These six T are critical associated with product quality. In order to achieve the best practices of managing supply chain risk process, the six Ts in our integrated framework are interpreted as the six important drivers in risk management process:

- (i) Traceability is the ability for tracking a physical product's flow towards the production process and supply chain.
- (ii) Transparency refers to availability for providing relevant product and process information of the 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 with the ability to detect defects in products. There are majorly two vital factors affecting testability directly: (a) the complication of the product structure, and (b) the long testing time of quality dimension.
- (iv) Time is the duration of a particular process, it includes the order lead time, production lead time and logistics lead time.
- (v) Trust is concerned with expectation of parties to behave according to acquired commitments.
- (vi) Training is the process to improve awareness about international standards of quality, safety and best practices.

Case study

The case study research method permits to have a view of the real world events. This technique is for exploring areas in which theoretical data is limited and still just beginning [21]. Perry [22] claimed that case study approach is the most useful and appropriated method to examine research problems. The challenge for using case study is to separate the important data from the irrelevant. The researcher is actively involved in the meeting of the information to be used to answer the research question.

The case studies are exposed to a number of criticisms related with their natural scientific design. According to Yin [21], case study should have clear designs produced 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 to mitigate the risk, it is a process which provides specific insight and exposes the risk related issue hidden in the supply chain.

Under the assist of risk management framework, the company manager could examine the quality risk from both supplier and customer perspectives, and gain the specific insight about risk in their global food supply chain.

Case company background

A Central America SME – *El Mundo* (the real name has been disabled for security reasons) was selected rather than a large since SME is simpler to investigate the complex process to manage the product quality risk through the global supply chain. In addition, the SMEs represent the major force of the market income in Central America. Moreover, *El Mundo's* one of the leading distributor that supplies their imported products to most of Central America regional market.

There are about 45 employees in *El Mundo*. It distributes popular products with high volume, and its major supply base includes 12 first-tier suppliers which mainly located in America. More than half of the first-tier suppliers are large firms and mostly located in Mexico.

The company relies much on importing, 100 per cent of the company's products comes from international suppliers. For example, one of the key foreign suppliers of diapers and pellet are located in United States and Mexico.

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

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

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

The collected of accurate information related with the product quality risk was complex and required analysis and research through the innovative interview and questionnaire techniques. PQR framework in global supply chain has consistently offered the most up to date and relevant information to build 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 required the participation of the whole organisation structure members. In order to understand this framework, the following below sections should be explored.

Customer's focus- the desired quality

Quality dimensions of *El Mundo* customer includes are general features, reliability, durability, conformance and quality. The companies offer the following products: Cereal, Pallet, diapers, candies, baby bottles, mayonnaise, baby wipes, sanitary towels, cloth hangers and marshmallows which are target to fulfil customer s' requirement. However, the company does not have any clear process capable to meet the specifications required by customers. Current processes do not provide a very formal quality controls and feedback according to customer requirement.

Supplier's 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 company's suppliers should be assessed. Base on the interview with the suppliers, four major quality related risks were identified. These risks types with their risk drivers are showed in the below table.

Table 1. Risk dimension in sub-tier supplier

Risk dimension	Description
Quality Risk	Poor quality control during production process.
Price Risk	Cutting price of supplier since using a lower grade material.
Technology risk	Poor technology in quality inspection facility.
Environmental risk	Contamination may happen due to poor environment in storage and transport.

Source: Owm elaboration.

A benchmarking team which includes company's directors and supplier partners organised in order to reduce product quality risk base on the risk identified. Both parties have to make contracts of commitment. This group should define actions plans in different periods of time and clear paths to improve manage product quality through supply chain. The purchasing director has terminated some suppliers' relationships where there are high risks.

Six Ts' risk management driver

Traceability

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

Transparency

Goods supply chain transparency is relatively low for this company because it has lack of visibility in Supplier production process. This means the company does not have any information about its supplier's sources and production practices. The company maintains physical transparency of 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 very difficult to test it. There is a risk in detecting contaminated food through the transportation and unload process. At the moment, the company implemented the 10 rule as quality test policy in which 10 per cent of unload product is checked.

Time

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

Trust

In the food industry, one strategy for safeguarding quality is investment in long term relationships with truthful suppliers. The company has a strong relationship with their suppliers that allows to cooperate and development of trust. The company's owners had visited the suppliers processing plants.

Training

The company has an annual technical assistance about its processes. This means that the company contracts an external organisation which inspects, evaluates and implements new company's practices to improve the flow of goods and information. At the moment, the company is not actually interested in

any training related with its products portfolio, and also its regional expansion. Insuring the safety of the food products along the supply chain has been a challenge to the company which had product recalls.

Discussion

El Mundo managers are very impressed with the proposed product quality risk management framework. The benefits include:

- (i) Detailed and accurate customer information is 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) Provide support to the critical challenges regarding global food supply. The framework presents research themes in product tracking systems, transparency, quality controls programs; reduce product transit time, trust relationships and constant quality training.
- (iii) Simplify identification and communication of risks associated with organizational structure. The Logistic Manager pointed out that "It is easy to identify what are the risks that the company is currently facing..."
- (iv) A method to evaluate the risk of multi-tier suppliers' network.
- (v) Provide information to organise action plans to increase the flexibility in manageable quality products.
- (vi) Encourage predictable, secure, standards and best practices, maintainable, reliable principles.

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

- (i) Given the diversity of supply chain agents, it may not consider the application of this framework to all cases because each supplier's member has different purpose. It is a general conceptual framework.
- (ii) Application of the framework required reliable data collection methods.
- (iii) Fully participation of the organisational structure members. In the view of the CEO, "sometimes it is complicated to explain to the supplier why it is so important to collect this data..."

- (iv) Require commitment from whole multi-tier supply chain network.
- (v) Require availability of information and company's documents.
- (vi) Availability of time - the purchasing manager comment that, " In order to apply the entire framework, 2 months were required...".

Conclusion

The globalisation and the fast improvement in high quality products have brought high level of market pressure to the companies. The global sourcing providers of food and ingredients are growing fast. Consequently the number of agents involved in the supply chain network is increased, making supply chain quality management very difficult. For this reason companies have more delay points and greater uncertainties. Today more coordination, communication and monitoring are required for firms. The clear problem is that even a minor incident in one part of a supply chain can have disastrous effects in other parts of the supply chain network. So suppliers are providing components (or materials) that are not meeting quality specifications. A series of company scandals, reputation and recall products and cost are hitting the food industry.

The companies are being forced to modify their old operations management methods, and develop better systems to guarantee that customers are satisfied with the products.

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

Even though there are many risk management options which are aimed to reduce risk, it should be noted that there is not any framework that propose an accurate approach in which all the members should 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 se-

quential form of 5 stages. However, this approach is focus on in general in the supplier's risk without considerate the product quality.

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

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

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

During the adoption of the risk management framework, company's issues related with the quality risk along multi-tier network were exposed, and actions plans were proposed. However, the proposed risk management framework is not a tool to mitigate the risk, it is a process which provides and exposed the all the issues related with product quality risk. As a result the exposed of organisational incidents should reduce in the near future. The application of quantitative methods to measure the quality risk should be considered for further research. The analysis of the case study was complicated since it was made from different country without any company visit during the evaluation time. Due to information delays in the interviews and surveys, it was proved to be very hard the data collection process.

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

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