

Risk Management Practices for Managing Product Quality in Global Supply Chain

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Abstract: In recent years, product recalls due to quality and safety problems have been surging. In 2009, the product recall cases in EU countries had doubled to 1686 in four years (RAPEX, 2010). The rise of recent product recalls suggests that manufacturing firms are particularly vulnerable to product safety where goods and materials have been sourced globally. For firms and policy makers, this raises the question of whether prevailing quality management practices and regulations in the global supply chain environment are fit for purpose, and what form of risk management practices can help to manage product quality effectively. In this paper, we develop a conceptual framework concerned with the preservation of product quality and safety in global supply chains. We describe the complexity of global supply networks and the magnitude of global sourcing, both in terms of product quality risk and safety issue. The goal of this research is to develop a supply chain risk management framework through an integration of diverse research stream related to management of supply chain risk. In particular, four supply chain risk management practices are proposed to mitigate the quality risk which is inherent from the supply network.

Keywords: global supply chain; product quality and safety; supply chain risk management

I. Introduction

In recent years, the number of dangerous consumer products rose rapidly in EU countries [1]. As shown in figure 1, reported cases in quality and safety problem of consumer product doubled in four years and more than half of the cases are from Chinese imports. Heerde et al. [2] indicated the rise of the recall cases is partly related to the increased complexity of products, closer scrutiny by manufacturers and policy makers, and higher customer demands.

In all recall cases, both government and consumers insisted on the promptly removal of products from the marketplace due to the health and safety concerns. Product recalls tend to cause major consumer panic, are very costly and detrimental to firms as illustrated by the recent case of Sanlu tainted milk which had to file for bankruptcy proceedings subsequent to mounting health liability claims. Needless to say, product recalls are detriment to firms' reputation, and can be seen as a firm or nation "worst nightmare" [2].

Recent product recalls also suggest that manufacturing firms are particularly vulnerable to product safety where goods

and materials have been sourced via a global supply chain with poor visibility [3] i.e. lack of information on suppliers' materials origin. Global supply chain has evolved into multi-tiered environment which increases the uncertainty and adds quality variance to the final products.

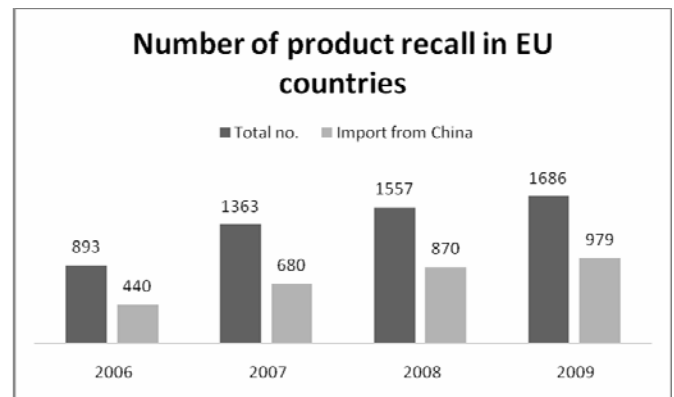


Figure 1. The number of product recalls in EU countries [1]

For example, the toxic sofa incident in 2008 safety problem with the sofas, which were mainly sold by Argos and Land of Leather, were believed to have caused by a potent fungicide Di-methyl Fumarate (DMF). That caused number of cases in skin burns and allergies. The sofa retailers now may be faced to pay out up to four million pounds in compensation, replacement furniture and legal fees [4]. Though UK furniture retailers did not manufacture and add the toxic, the toxic are originated from their sourcing partners.

The intent of this paper is not to propose a foolproof universal formula for resolving the product quality and safety problem in global supply chain. Instead, we are going to address the important aspects of product quality and safety issue in multi-tiered environment, and the root-causes of these risks. We also develop a conceptual risk management framework that will provide a focus to manufacturing firm for managing quality and safety issue in global supply chains.

The remainder of the paper is organized as follows: Firstly, we outline the root causes and discuss the important issues from recent product harm scandals: a) the evolution of global supply chain and, b) the product quality and safety problems that is inherent from the supply network or caused by the brand owner. Following this, we proposed supply chain risk management model with four practices, including risk shifting, risk absorption, risk prevention and risk correction, for reducing the possibility of the occurrence of

quality risk, and alleviating the outcomes of it. In addition, propositions derived from the proposed model form the basis of a future research agenda regarding the positive relationships between supply chain risk management practices and firm performance.

II. Root Causes of Product Quality and Safety Problem in Global Supply Chain

Product quality and safety risk can destroy a firm favorable reputation, cause major revenue and market-share losses, lead to costly product recalls, and devastate a carefully nurtured brand equity [2]. In light of this, there is a growing number of research looking into the impact of product harm crisis in the global supply chain, for example, on global supply chain quality management [5], on brand equity [6], on stock market reaction [7], and on marketing effectiveness [2]. However, the severity of quality and safety risk and its implications in a multi-tiered China supply chain are not fully understood in the operation management literatures.

Product quality and safety risk is viewed as product harm crisis which is “discrete, well-publicized occurrences wherein products are found to be defective or dangerous”, and well documented in marketing literature [2, 6, 8, 9]. In this paper, we focus on the product quality and safety problems in the supply chain context. Thus, the definition of Quality Risk in supply network can be seen as: “*Risk that production input do not meet quality specifications that originated from individual supplier failures*” [10].

Most of these product quality and safety problems result from the uncertainties created by global sourcing. Firms must explicitly and thoroughly account for the uncertainties when they make decision to source the materials through global supply network.

2.1. Supply chain complexity

The global sourcing provides access to cheap labor and raw materials, foreign market outlet, better financial opportunities, greater mix and volume flexibility, and improved the return on assets [5, 11-13]. Therefore, more firms now include global sourcing as part of their procurement strategy complicating the supply chain by increasing the number of entities involved [5, 14]. The severity and complexity of the product quality and safety risk have been magnified by the magnitude of the global sourcing issue. Moreover, it is not surprising that more than half of the productions of branded products are outsourced to vendor plants. These vendor plants may also purchase the material globally and form long supply chains, often cuts across various regions. Thus, the quality related problems may deteriorate when these vendor plants also outsource jobs to other vendor plants and the re-outsourcing process may continue [14].

Another uncertainty factor that influences the effectiveness of quality assurance of product is quality variance due to low transparency in supply chain. The dramatic increase in

product recalls reveals that the multi-tiered supply chain with low transparency is particular vulnerability to quality and safety risk. Although most companies have some sort of risk management framework to identify and assess risk, the effectiveness is especially affected by the level of information sharing among the suppliers [3]. Moreover, the information asymmetry between the buyer (manufacturer) and seller (supplier) firms affects the effectiveness of quality control between supplier, manufacturer and customer (Tomlin, 2006). In practice, suppliers often have better information about their likelihood of experience a production quality than the manufacturers they serve, because of the suppliers’ private knowledge of their information about, such as, quality level of the finish goods, the quality audit of their suppliers, the incoming inspection of materials, etc. However, this information may not be shared with their buyers.

2.2. Product design and manufacturing faults

Most parties, including media and consumers, assume that the Chinese suppliers/manufacturers need to take full responsibility of most recalls. In fact, the Chinese suppliers only involve in manufacturing the toy, but not designing them. The responsibility of lead paint toys may lie completely to the manufacturers/suppliers in China, but not the one with design flaws. Lead-paint toy imports are only responsible for about ten percent of these recalls [15]. The recalls of design flaws and the manufacturing flaws (exclude the use of lead paint) were responsible for the balance.

The toy recalls can be distinguished as a) design flaws, and b) manufacturing flaws. The design flaw includes the use of small detachable parts, such as button eyes, beads, sharp edges, and any design that may cause strangulation. The manufacturing flaw includes faulty assembly, poor materials, the use of toxic chemical, and contaminated during manufacturing process. The increase in design flaws incidents reflects the misunderstanding of the safety implication of toy design. On the other hand, the increase in manufacturing flaws may be caused by the poor management of China supply chain.

However, some kinds of product do poorly with respect to testability construct. For example, the contaminations by foreign substances not previously encountered (Roth et al., 2008). In the Sanlu melamine milk, the buyer firm is unexpected that the industrial materials will be added in a food product. That is the reason why the testing procedures in several supply chain tiers cannot detect the problem.

III. Supply Chain Risk Management Practice in Global Supply Chain

Supply chain risk management (SCRM) in this research is defined as the set of concrete actions undertaken by an organization to promote effective risk management practices in mitigating quality risk in its global supply chain. These practices are risk management strategies that are especially

aiming to manage quality problems from the sourcing materials which may cause contingency and catastrophic product harm incidents. Thus, it does not include in the focus of generic supply chain risk management context (i.e. demand risk, operations risk and security risk). In reviewing and consolidating the literatures (as well as interviews with practitioners and experts) [2, 16-19], the SCRM practices are proposed to be a multi-dimensional concept, including four distinctive dimensions: risk shifting, risk absorption, risk prevention and risk correction. Table I shows the literatures of which the four SCRM practices were consolidated.

Table I. Supply chain risk management practice in literature

Risk Shifting (RS)	Literature Sources
Setting up high penalty for product imperfection	[20], [3]
Designing contract with the consideration of external failure costs	[20], [21]
Risk Absorption (RA)	
Solve quality problems jointly with suppliers	[17]
Task programmable	[17], [22]
Quality improvement by investment to supplier's facility	[23]
Risk Prevention (RP)	
Strategic supplier management or QMS implementation in supply chain members	[24], [25]
Third party inspection and certification	[26]
Supplier selection and quality audit	[27]
Setting up proper incoming inspection strategy	[21], [26]
Risk Correction (RC)	
Setting up product recall strategy	[6], [2], [7]
Proactive Product Recall	[16], [2]

Risk shifting (RS) is the SCRM practice that the buyer firms shift the responsibility of the economic losses due to quality and safety problem of the purchasing materials to other parties, such as supplier and insurance company. Risk absorption (RA) involves the corporation with supplier to jointly reduce the quality problems from the purchasing materials. Risk prevention (RP) is the practice to prevent and stop the poor quality and harmful material being reached to the buyer firm and end customers. RP practice includes the internal actions to reduce opportunities of quality risk occurrence before it happens. Risk correction (RC) is the set of corrective actions taken after the delivered product are revealed and proven that it is in poor quality or even harmful to customer.

RS and RA are already defined as opts for diverse risk allocation strategies in relational contact management context (Camuffo et al., 2007). RS also named as "risk transfer" in other risk management literatures [28]. RP and

RC practice in this study refers to some elements in the classical prevention-appraisal-failure (P-A-F) model. The P-A-F model concerned about the quality costing in quality management context. By contrast, RP and RC proposed in this research only concern the quality problem of sourcing material on risk management context, thus the activities about internal production and internal failures in the P-A-F model are not included. Moreover, activities of prevention (i.e. supplier quality assurance) and appraisal (i.e. setup inspection and test, evaluation of materials and spare) in P-A-F model, are both grouped under RP dimension in this study. It is supported in SCRM literatures [29, 30] that inspection and assessment activities are grouped as RP. On the other hand, the activities in responding the external failure in the P-A-F model are grouped in risk correction practices.

The four SCRM practice can be viewed from long-term and short-term perspectives. RS aims to achieve the appropriate supplied products with a lower price and only remain short-term relationship with the supplier, as the supplier can be replaced by another one in the supply market. RC is the short-term practice that will be only employed if the delivered products are found to be imperfect in quality and safety. On the other hand, RA is a long term practice that the firm needs to develop a supply chain integration relationship with the suppliers. For improving the quality of purchasing items to meet the buyer specification, buyers firm may provide supplier training or even investments in supplier's facilities. RP is also a long term practice that involves the adoption of supplier evaluation approach which is a continual process to maintain a certain quality level of received materials.

3.2. Risk Shifting (RS)

The major aim of risk shifting is transferring the negative outcomes of quality risk to other parties. Firm normally adopts risk shifting while purchasing the "marketing goods" (i.e. the buyer purchases the component that has been fully designed and manufactured by the seller) from supplier. With risk shifting approach, buyer firm believes that the value of the future relationship with the supplier is not valuable enough [17] to develop as strategic partners. Thus, the supplier will take the full responsibility of ensuring the material quality by themselves. Buyer firm transfers the negative outcomes of quality risk to the supplier by charging a high penalty cost if defects are found in the incoming inspection. The amount of defect penalty aims to cover the external failure cost from the material defects which including the rework or replacement. Also, the buyer firm can ensure the material quality by reducing the level of defective allowances. In sum, the buyer firm has transferred the economic loss of quality imperfection of material to supplier which needs to take its own effort to ensure the quality of the delivered products alone.

Another possible way of risk shifting is transferring the risk by having product liability insurance [31, 32]. The aims of the product liability insurance are to protect the business from claims related to the production and sale of products, food, medicines to the public. It can cover the liability of the manufacturer for losses or injuries to the consumer or user [33], whatever the quality problem is caused by manufacturing flaws or a designing defects. Though transferring the risk by having product liability insurance is costly, the average amount of coverage is around one to five million pounds that mainly depends on market size.

Although risk shifting approach can provide benefit to lessen the economic loss from material defect, there is no knowledge contribution about the design and production from the supplier to the buyer firm. i.e. the quality of the sub-component are not observable by the buyers. Moreover, the buyer firm has little knowledge of the supplier's process, cost structure and material origin [17].

3.3. Risk Absorption (RA)

Risk absorption is an opposing strategy to risk shifting. In risk absorption, buyer firm believes that the value of the future relationship with the supplier is valuable, and therefore squeezing the prices or heightening the penalty cost is no longer appropriate [17]. The firm concerns about maintaining long-term relationships with reliable and capable suppliers for providing quality components. Firm needs to develop a supply chain integration relationship with the suppliers while employing risk absorption strategy. Thus, buyer firm's managers need to make decision about investing to the supplier's facility or sending technical staff to supplier's site for improving the quality performance, so the buyer firm delegates to suppliers the task of producing different components and decides whether and how to share the risk arising from suppliers' production.

While the buyer firm employs risk absorption for new product development, a template of activities is provided by the buyer firm [22]. In general, the more programmable the supplier's task, the easier it becomes for the buyer firm to control the supplier's behaviour. If the component is fully designed by the buyer firm, it is easier to observe the supplier's product quality as information concerning the supplier's behaviour is more readily available. The buyer firm probably has a fairly detailed knowledge, not only of the overall final product architecture, but also of the components the supplier manufactures. This implies that the transparency between the buyer firm and supplier is improved. Moreover, buyer firm can know the full knowledge of the supplier's processes and even the cost structure. Task programmability can reduce information asymmetry among the supply chain. In consequently, the buyer is more willing to absorb risk [17].

3.4. Risk Prevention (RP)

Risk prevention is the practice to prevent the poor quality and harmful material being reached to the buyer firm. We

associate risk prevention with sets of activities which are performed in continual basis for identifying the potential quality and safety problem before the material is being process and manufacture to final products that may reach to the market. These activities majorly are the internal operations of buyer firm in preventing the negative risk incidents from happenings. The activities involves: (i) setting up a thorough supplier evaluation system, (ii) adopting certain risk management framework for identifying and evaluating quality risk, (iii) setting up proper incoming inspection strategy to different categories of products, (iv) employing third party inspector to ensure the product quality. Some banded firms usually tighten quality standards after the series of product recall scandals, such as Wal-Mart. They setup new quality standard for their potential suppliers, require more transparency in the supply chain, as well as require and force their suppliers to provide information about the upstream suppliers [34]. Firm also needs to apply risk analysis and assessment tools for identifying and evaluating risks in the supply chain operations. In order to access the risk exposures, the risk analysis and assessment framework should identify not only direct risk to its operation, but also the potential causes or source of risks at every significant link along the supply chain [35]. Besides, firm adopts some sort of inspection strategies that involve decision making in the resource allocation in the quality appraisal by incoming inspection or third party inspection. Incoming inspection verifies conformance to specifications and provides indirect information on the supplier's quality-enhancement effort [26]. For developing inspection strategy, firm also needs to consider the long term investment for improving effectiveness of vision inspection and other automated technologies to a certain inspection level, By contrast, firm may adopt a costly third party inspection but with a better confidence to the customer.

3.5. Risk correction (RC)

The firm's handling a product quality and safety problem seems one of the most important purchase influences and appears to be a critical determinant of the product harm impact on consumer beliefs [6, 7]. For better preparation of the risk response, such as proper product recall strategies can diminish the impact to firm's financial performance [2, 6, 7]. The major distinction among various product-recall strategies is whether the firm acts passively and defensively or proactively and responsibly. Some research suggests that a proactive recall strategy is a better way in responding risk [6]. If the firm or the government agency discovers a product flaw that might necessitate a potential recall, the firm adopting proactive strategy is more likely to work with the agency and issue a voluntary recall early in the process. Such recalls often occur when the firm becomes aware of a potentially hazardous product through internal inspections and before any consumer safety incidents have been reported to the firm or agency (CPSC 1999). In contrast, the passive approach may entail delaying the recall process and/or trying

to shift the responsibility to other firms or entities. These recalls tend to be issued much later in the investigation process and usually happen after serious consumer complaints have been made to the firm or the CPSC. Unfortunately, such recalls are often issued after serious injuries and/or death to consumers [9].

3.6. Supply Chain Risk Management Practice and Firm Performance

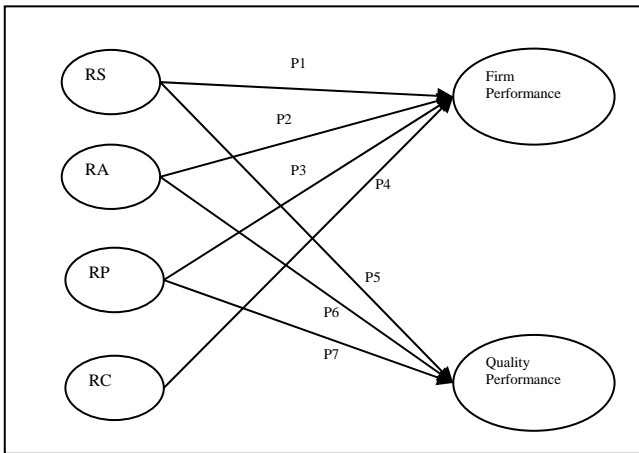


Figure 3. The conceptual SCRM performance model

In figure 3, it shows the relationships among the four proposed SCRM practices, quality performance and firm performance. Firm performance usually defined as the achievement of financial and market share objectives [36]. In the literatures, firm performance has framed as a combination of operational and financial performance (such as gains in sale, return on asset, profit margin)[37, 38].

The higher level of four supply chain risk management practice is expected to increase the firm performance. For examples, (i) the higher level of risk adoption is associated with higher task programmability in supplier production, which can consequently enhances the risk perception to the quality of the sourcing material, so as to reduce the external failure cost from product defects [17]; (ii) The better planning in risk shifting is linked with penalizing the suppliers' product defect to cover the external failure cost[17]; or having product liability insurance in advance for covering the costly customer claims, (iii) Advanced risk prevention is associated with better inspection policy for lowering the external failure cost [20]. (iv) A better risk correction plan (for example, decision to select an appropriate recall strategy) can mitigate the financial impact of the product harm incident [2].

Moreover, the scale measurements of firm performance usually do not include the quality performance. Thus, the quality index, which is proposed by Primo and Amundson [39] and that is based on Gravin's eight dimensions of quality [40], are adopted as the measurement scales to the impacts of SCRM practices to the product quality. Moreover, risk absorption, risk shifting and risk prevention are

associated with the product quality, as these three practices include the actions to ensure the quality of materials from supply network. Besides, risk correction does not involve any action that improves the product quality. Thus, based on these rationales, the following propositions are proposed:

Proposition 1 (P1): Higher level of risk shifting will positively affect firm performance

Proposition 2 (P2): Higher level of risk absorption will positively affect firm performance

Proposition 3 (P3): Higher level of risk prevention will positively affect firm performance

Proposition 4 (P4): Higher level of risk correction will positively affect firm performance

Proposition 5 (P5): Higher level of risk shifting will positively affect quality performance

Proposition 6 (P6): Higher level of risk absorption will positively affect quality performance

Proposition 7 (P7): Higher level of risk prevention will positively affect quality performance

IV. Conclusion

In this paper, we discuss the product quality and safety risks behind the recent product recall scandals that inherent in global supply network, including the root causes of the product recalls: the magnitude of outsourcing strategies and the complexity of global supply chains. This study attempts to clarify the understanding of quality risk in global supply network. The raise of the number of product recalls reveals that the globalization forms a complex supply chain structure. The more entities are involved in the supply network, more uncertainty to the final product quality. Thus, it constructs an amplification of quality variance across the supply chain due to the increasing level of information asymmetry among the supply chain members. Moreover, the complexity and testability of product also affect the effectiveness of quality assurance and the inspection.

Further, this paper proposes four supply chain risk management practices in reducing the possibility of the occurrence of quality and safety problem in global sourcing and alleviating the negative impacts of quality risk. The proposed supply chain risk management practices include: risk shifting, risk absorption, risk prevention and risk correction. Although it is not possible to eliminate all the quality risk from global supply network, we can find a possible and systematic approach to mitigate the quality risk by adopting the appropriate settings of these four supply chain risk management practice. While this study contains its own limitations, it does provide a starting point for future research concerning the value of supply chain quality risk management and the impact of supply chain risk management practice on organizational performance. In addition, the future work of this research will be the creation and validation of multi-item measurement scales of these

four supply chain risk management practices, and the empirical test of the supply chain risk management model.

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