The impact of supply chain relationship on food safety management in global food supply chains

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Abstract

The paper explores the interrelationships among firms' food safety management system (FSMS) performance with (1) criteria of supplier selection, (2) quality of supply relationships, (3) level of collaboration, (4) level of external supports. Then, hierarchical cluster analysis is performed to classify firms based on the scores of each group of FSMS activities and compare these aspects of supply relationship between groups of firms that perform "best practice" FSMS and the rest. The results suggest that the higher scores of these aspects could lead to the higher scores of FSMS activities of food firms and highlight the differences between firms.

Keywords: food safety management, supply chain relationship

Introduction

Food safety is the most crucial component of the food quality besides sensory properties, shelf-life time, reliability and convenience (Aramyan *et al.*, 2007). Implementing a food safety management system (FSMS) is a regulatory requirement for every food firm in the global food supply chain (CAC, 2009). The success of each company's FSMS in preventing foodborne hazards depends on its correct implementation and application (Kafetzopoulos, Psomas and Kafetzopoulos, 2013). At any scale, it could be influenced by many factors since the global food supply chains. The supply chains consist of a large number of stakeholders and are involved with an enormous variety of structures, logistics. The participants will undoubtedly change rapidly, scale-up and diversify continuously (Gorris, 2005). In the global supply chain, as companies have outsourced manufacturing to lower cost countries around the world, along with pressures for lower costs, the additional complexity of the supply chain that will continue to lead to safety problems (Marucheck et al., 2011). The role of supplier selection is questioned because safety is still considered as less important than other conditions. This lower priority could be a factor behind the frequency of food safety incidents (Voss et al., 2009). As requirements of many standards, supplier selection is vital to ensure that the suppliers can meet the particularised needs of food safety through the process for the selection, approval and monitoring (e.g. ISO 22000).

Furthermore, establishing collaboration and developing a more integrated relationship among the parties within the supply chain are essential to avoid corrupted connections in the food supply chain. Many authors confirm that "closer" relationship between manufacturers and their suppliers bring many advantages including better quality (Fynes et al., 2005), lower costs and reliable delivery (Goffin et al., 2006). Finally, under pressure of more stringent market demands and regulatory requirements, firms' FSMS within the international food supply chains need to be continuously improved. This leads to many difficulties since the burden and costs of more stringent food safety monitoring being shifted from importing countries to exporting countries, from developed countries to developing countries, from retailers to suppliers (Henson and Humphrey, 2009). Consequently, they search for external supports in term of finance to be able to invest in structure, equipment and staff training (Qijun and Batt, 2016), information to expand the market and update their FSMS to compliance with changing requirements from other stakeholders in the supply chain (Fotopoulos et al., 2009). Therefore, the purposes of this paper are two-fold, first, to explore the relationship among (1) criteria of supplier selection, (2) quality of supply relationship, (3) level of collaboration, (4) level of external supports and firms' FSMS activities score. Second, to compare these aspects with groups of firms that perform "best practice" FSMS and others.

Literature review

Like other kinds of supply chains, food supply chains are the networks of multi-scale stakeholders from farm to fork including farmers, processors, exporters, importers, distributors and retailers. It is obvious that there is more than one available supplier to ensure supply chain continuity and suppliers are a crucial part of firms' success. Supplier selection, therefore, has become more and more critical to food firms to consider and evaluate many tangible and intangible factors in selecting and monitoring their suppliers' performance. Under the strong impact of food safety standards, factors for supplier selection of food industry are not only defined by price, quality, delivery performance, service, etc. but also added criteria related to food safety management such as suppliers' certificates and inspection results to ensure inputs safety (Trienekens and Zuurbier, 2008) since there is no perfect risk prevention system. Except for the study of Voss et al. (2009) confirm that safety is still considered as less important than other conditions, so far there is no research compared firms in term of their FSMS score and explore how they select suppliers.

Besides, the development of the relationships with strategic suppliers, together with the coordination and monitoring of their behaviour concerning the food safety are challenging to food firms (Marucheck et al., 2011). The study of Kirezieva et al. (2015b) confirms that collaborative/supportive supply chains contribute to more advanced FSMS and good system output as firms demonstrated advanced knowledge and expertise about safety and quality management. These factors are adopted as chain characteristics in the group of the context factors (product, production, organisational and chain characteristics) affecting design and operation of activities in the FSMS from several studies (Luning and Marcelis, 2007, 2009; Luning et al., 2011; Kirezieva et al., 2013; Kirezieva et al., 2015a) that refer to the conditions of supply relationships with other organizations in the chain. Researchers have not yet treated the definition of a collaborative/supportive supply chain in much detail with limited information such as severity of stakeholder requirements, the extent of power in supplier relationships, the degree of information exchange in supply chains and so on. In addition, one question

that needs to be asked, however, is whether the support from other parties such as non-profit organisations (NGOs), business associations and financial institutes are significantly correlated to firm's FSMS activities. Many authors point out that implementing FSMS requires regulatory and market opportunities information, technical and financial support from these parties (Kirezieva et al., 2015b). Additionally, Qijun and Batt (2016) confirm that difficulty in obtaining external funds is perceived as a significant financial barrier to adopting a certificated FSMS. Although these studies have highlighted the influence of supply chain relationship on food safety management, there remain some critical gaps that explain and clarify collaborative/supportive supply chains and how it could contribute to FSMS at food firms. In particular, four aspects of supply chains relationship including criteria of supplier selection, supply relationship quality, supports and level of collaboration between food firms.

FSMS is highly customised for each firm based on a result of the implementation of various quality assurance and legal requirements into its unique production, organisation and environment (Jacxsens *et al.*, 2011). Though there are key elements of FSMS extracted as food safety requirements of EU legislation (EC, 2002), Codex (CAC, 2009), ISO 22000 (2005) including prerequisite programmes (PRPs), HACCP principles, and other components of FSMS such as traceability, control of nonconformity, validation, verification, and improvement. In this study, we adopt these food safety requirements to construct FSMS performance based on the mean of scores on these critical elements to identify "best practice" firms in the research sample.

Methodology

The chosen sample for this study is food manufacturing and exporting companies in Asian developing countries since the food industry has emerged as a leading sector in Asia, namely China, Thailand and Vietnam as the largest exporters of food products (FAO, 2016). Snowball sampling method is used to recruit volunteered responders who are in charge of FSMS at firms answer to five-pages survey questionnaire to indicate their agreement to a range of questions regarding criteria of supplier selection, quality of relationship, level of collaboration and FSMS performance by mean of Likert scales (from 1 = low degree to 5 = high degree). The data collection timeline in three countries is from February to December 2018. Therefore, at this stage, there is only one country - Vietnam has finished. The results of this paper are analysed from 54 Vietnamese food exporters using SPSS 24. Based on the literature review of supply chain relationship and food safety management, the survey instruments are extracted as the following table (Table 1).

Table 1. Survey instrument

Group	Variables	Reference
Supplier selection criteria	(1) Price, (2) Certificates, (3) Distance (local or not) (4) Reliability; (5) Inspection results; (6) Flexibility; (7) After-sale service.	To address supplier-selection practice, we built on and compiled the lists of supplier-selection criteria from these different sources and considered criteria that were consistent across the previous studies of Kirezieva et al., (2015); Chen et al., (2013); Trienekens & Zuubier, (2008); and Lambert, Emmelhainz, & Gardner, 1996

Quality of supply relationship	(1) Trust; (2) Commitment; (3) Interdependency.	In the food supply chains literature, most of the discussion in quality supply relationship focuses on its constructs including trust, commitment and interdependency are characteristics of successful partnerships among supply chain partners (Anderson & Weitz, 1989; Mirani, Moore, & Weber, 2001, Mohr & Spekman, 1994).
Level of collaboration	(1) Emerging problems solving; (2) Continuous improvement programs; (3) Information exchange; (4) Planning and goal-setting activities.	These constructs to identify the level of collaboration are extracted based on the previous studies of Chen, Sohal, & Prajogo, (2013) and Cao et al., (2010)
External supports	(1) Stakeholders in supply chains; (2) Government and authorities; (3) Financial institutions; (4) Business associations; (5) Non-governmental organisations.	These constructs to identify the level of supports from which firms are receiving are extracted based on the previous studies of Qijun & Batt, (2016) and Fotopoulos et al., (2009)
FSMS activities	**PRPs** (1) Construction and layout of buildings and associated utilities; (2) Layout of premises, including workspace, employee facilities, laboratory facilities, storage and warehouse; (3) Supplies of air, water, energy and other utilities; (4) Supporting services, including waste and sewage disposal; (5) Suitability of equipment and its accessibility for cleaning, maintenance and preventive maintenance; (6) Management of purchased materials; (7) Measures for the prevention of physical, allergen and microbiological cross-contamination; (8) Cleaning and sanitising programmes are established	PRPs are defined as "Basic conditions and activities that are necessary to maintain a hygienic environment throughout the food chain suitable for the production, handling and provision of safe end products and safe food for human consumption" (ISO 22000, 2005) PRPs play the essential role of in the context of supporting HACCP for effective FSMS, and they are as crucial as HACCP in term of safe food assurance.
	Principles of HACCP (1) Hazard analysis (including hazard analysis, identification and assessment); (2) Critical control points (CCPs) identification; (3) Establishing critical limits; (4) Monitoring procedures; (5) Corrective actions; (6) Verification procedures; (7) Record-keeping and documentation. **Other activities (OA)** (1)Traceability; (2) Control of nonconformity including	The Hazard Analysis and Critical Control Point (HACCP) system is a science-based system created to identify specific hazards and actions to control them in order to ensure food safety and quality (Arvanitoyiannis, Varzakas and Koukaliaroglou, 2009). Preventing problems from occurring is the desired goal underlying in any HACCP system. The HACCP consists of seven principles that outline how to establish a HACCP plan for each operation to reduce the risk of a food safety failure. *Traceability* is the ability to trace and follow food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed,

	a. Corrective action b. Procedures to handle potentially unsafe products; (3) Validation a. Control measures b. Sufficient evidence; (4) Verification a. Internal audits b. Required records and documents c. Internal communication d. External communication; (5) Improvement a. The ability to improve and continually update b. The active in seeking certification or registration	through all stages of production, processing and distribution according to The European Union (EU) regulation 178/2002 (EU, 2002). *Control of nonconformity* is defined as the act of identification and control potential unsafe products that are affected because critical limits for CCP(s) are exceeded, or there is a loss of control of operational PRP(s) with regard to their use and release to ensure safety (ISO 22000, 2005). A documented procedure shall be established and maintained defining a) the identification and assessment of affected end products to determine their proper handling, and b) a review of the corrections carried out. *Validation* is "obtaining evidence that a control measure or combination of control measures, if properly implemented, is capable of controlling the hazard to a specified outcome." as Codex (CAC, 2008) defined. The food safety team shall plan and implement the processes needed to validate control measures are effective and capable of ensuring control of the identified food safety hazards and provide sufficient evidence that the specified monitoring and measuring methods and equipment are adequate to ensure the performance of the monitoring and measuring procedures (ISO22000, 2005). *Verification* is "the application of methods, procedures, tests and other evaluations, in addition to monitoring, to determine whether a control measure is or has been operating as intended" (CAC, 2008). The fundamental role of verification is to ensure that the FSMS is functioning as designed and is effective. The organisation shall conduct internal audits at planned intervals to determine whether the food safety management system is implemented efficiently and updated based on evaluation and analysis of the result of verification activities and all records and documents required by the food safety management system are controlled adequately at food company (ISO 22000, 2005). *Improvement*: FSMS is required to be improved and continually updated and firm actively seek certification or registration of their FSMS by an external organisation, or make a self-assessment or self-declaration of conformity (ISO 22000, 2005)

Of the 54 firms that completed the questionnaire, over half (36) are large firms (over 250 employees), and 18 firms are SMEs (11 to 250 employees). The joint stock company is the primary type of ownership structure with 51.9 % of firms, limited liability is the second with 40.7%, and only 7.4% of firms are the state-owned. The number of respondents is working at exporting food firms as CEO (22), quality control managers (16), trading managers (10) and supply chain managers (6). There are 60% of firms export more than 3000 tonnes per year, 22.2% of firms export from 500 to 3000 tonnes per year and the rest export less than 500 tonnes.

Data analysis results

The relationship between supply relationship and score of firms' FSMS activities

In order to explore whether there are the interrelationships among four aspects of supply relationship and score of firms' FSMS activities, Pearson product-moment correlation coefficient is used for the analysis. Preliminary analyses are performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. In general, there are positive correlations between four aspects of supply relationship and the mean score of firms' FSMS activities with $p < .05$, except for "price", "flexibility", "after-sale service" and "interdependency" have been removed out of the correlational table since the correlations are too weak ($r < .3$) or not significant ($p > .05$). The group of criteria to select suppliers has relatively weaker correlation compared to other groups with r from .3 to .5 excluding the criteria "inspection result" ($r > .5$) has a strong relationship with firms' FSMS scores as Cohen (1988) suggests for correlation strength. The results in Table 2 suggest that the strongest elements that correlate with firms' FSMS are "information exchange", "supports from business association", "commitment" and "inspection result" to select suppliers.

Identify "best practice" FSMS and compare between firms

Hierarchical cluster analysis is performed to explore how firms group according to the mean scores of each group of FSMS activities (HACCP, PRPs and OA) which resulted in three clusters. Table 3 is showing the distribution of the companies in the clusters according to size, certifications and the mean scores of each group for FSMS activities. Cluster 1 consists of 38 companies that have implemented and certified against several voluntary private standards, such as Global GAP, BRC, ISO, and private brand standards. This group has highest mean scores for three groups of FSMS activities, therefore, we consider this group has the "best practice" FSMS among firms in this sample. In cluster 2, ten companies are certified only against HACCP, BRC, and SQF. In the last cluster, six companies are not certified against any standard except for HACCP, which has lowest mean scores of HACCP, PRPs and OA. Moreover, the one-way between-groups analyses of variance (ANOVA) are conducted to explore the impact of those variables that are correlated to FSMS activities in three clusters. There is a statistically significant difference at $p < .05$ level in mean scores of these variables of each cluster. Among three clusters, the group of "best practice" has highest mean scores to all variables (Figure 1).

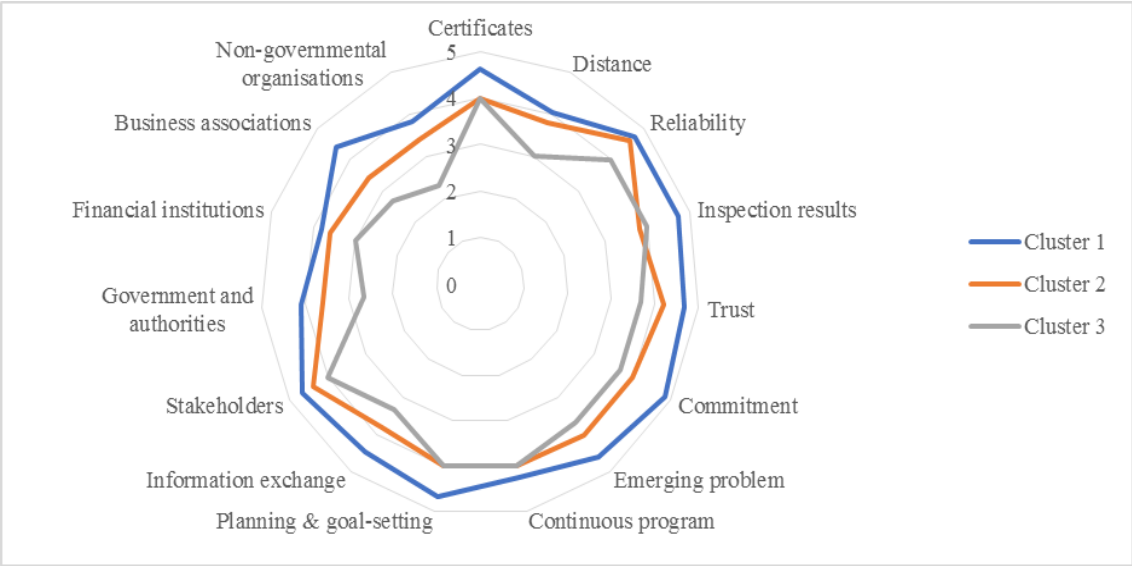

Figure 1. The differences in supply relationship aspects between clusters

Table 2. Pearson Product-moment Correlation

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. FSMS	-															
2. Certificates	.340*	-														
3. Distance	.353**	0.086	-													
4. Reliability	.394**	.298*	0.242	-												
5. Inspection results	**.507****	.581**	0.093	.464**	-											
6. Trust	.456**	0.114	0.093	0.221	.534**	-										
7. Commitment	**.631****	0.201	0.157	.286*	.667**	.838**	-									
8. Emerging problems	.453**	.310*	0.186	.535**	.277*	0.190	0.196	-								
9. Continuous improvement programs	.317*	0.180	0.198	0.217	.317*	.317*	0.158	0.238	-							
10. Planning and goal-setting activities	.462**	.437**	0.174	.379**	.592**	.283*	0.264	.500**	.273*	-						
11. Information exchange	**.653****	0.125	.300*	.515**	.291*	.291*	.401**	.330*	.477**	.322*	-					
12. Supports from stakeholders	.438**	.277*	.461**	.703**	.446**	0.210	.290*	.601**	0.040	.495**	.316*	-				
13. Supports from government and authorities	.616**	0.057	.632**	.432**	.507**	.433**	.486**	.375**	.283*	.480**	.506**	.578**	-			
14. Supports from financial institutions	.384**	-0.137	.564**	0.149	0.227	.364**	.377**	0.213	.377**	.328*	.479**	0.260	.732**	-		
15. Supports from business associations	**.636****	.279*	.509**	.349**	.276*	.398**	.362**	0.207	.366**	.374**	.722**	.345*	.535**	.418**	-	
16. Supports from non-governmental organizations	.483**	-0.006	.410**	0.211	0.127	.348**	0.260	0.262	.474**	0.018	.634**	0.148	.580**	.580**	.631**	-

* p < .05 (2-tails); ** p < .01 (2-tails).

Table 3. Profile of firms in each cluster

Cluster	Firm size			Certificates							FSMS activities			
	Small	Medium	Large	HACCP	ISO	BRC	GlobalGAP	SQF	IFS	Others	HACCP	PRPs	OA	All activities
1	2	4	32	38	28	26	14	8	12	10	4.92	4.84	4.71	4.80
2	4	4	2	10	0	2	0	2	0	0	3.83	4.18	3.80	3.92
3	2	2	2	6	0	0	0	0	0	0	3.33	3.25	3.15	3.23

Discussion and concluding remarks

The paper, while preliminary, has demonstrated empirical evidence regarding that several factors of supply relationship significantly correlated to FSMS activities of firms in the global supply chain and compared them to explore how food firms select suppliers, their relationships quality, and the level of collaboration as well as sources of support that they received. In the group of criteria of supplier selection, food firms show their interest in "reliability" and "inspection results" more than other criteria when selecting (Table 4). This finding is contrary to previous studies (e.g. Voss et at., 2009) which have suggested that price is preferred criteria than safety in selecting suppliers, three clusters of firms are sharing this common tendency for those criteria related to safety having higher scores compared to others. This is shown that food firms pay more attention to safety criteria with the aim of food safety assurance. A possible explanation for this might be that the laws, policies and standards regarding food safety management have been developed for the food industry, firms prefer more reliable suppliers who have food safety certificates and good inspection results to comply the laws and ensure safety inputs.

Likewise, the perspective of supply relationship quality also reflects this trending since the great extent of trust and commitment between firms and suppliers is related to the high score of firms FSMS activities, especially for the group of "best practice" FSMS, there is "closer" relationship with their suppliers. This cluster also shows a higher level of collaboration. In the group of level of collaboration, "information exchange" is the strongest correlational element to FSMS activities in all aspects of supply relationship (Table 3), however, in practice, the results show that it has not taken into sufficient consideration by food firms with their suppliers compared to "planning & goal-setting" and "solving emerging problems" (Table 4). This result suggests that firms should improve their current information exchanges with their suppliers, particularly cluster 3 which is the lowest score among firms in exchanging information related to FSMS with their stakeholders. Last but not least, support from government, authorities and business associations play essential roles for firms to achieve the aim of food safety as these parties' support are strongly correlated to FSMS scores. Nevertheless, in practice, support from these two parties that firms received are still lower compared to supports from stakeholders in supply chains.

Table 4. Mean scores for each indicator of supply chain relationship

Group	Variables	Cluster 1	Cluster 2	Cluster 3	All clusters
Criteria to select suppliers	Certificates	4.63	4.00	4.00	4.44
	Distance	4.05	3.80	*3.00*	3.89
	Reliability	**4.74**	**4.60**	4.00	**4.63**
	Inspection results	**4.74**	3.80	4.00	4.48
Quality of supply relationship	Trust	4.68	**4.20**	3.67	4.48
	Commitment	**4.84**	4.00	3.67	**4.56**
Level of collaboration	Emerging problems	4.58	**4.00**	3.67	4.37
	Improvement program	4.26	**4.00**	**4.00**	4.04
	Planning & goal-setting	**4.68**	**4.00**	**4.00**	**4.48**
	Information exchange	4.47	3.80	*3.33*	4.22
Supports from	Stakeholders	**4.68**	**4.40**	**4.00**	**4.56**
	Government and authorities	4.11	3.60	2.67	3.85
	Financial institutions	3.79	3.60	3.00	3.67
	Business associations	4.42	3.40	2.67	4.04
	NGOs	3.84	3.40	*2.33*	*3.59*

This study contributes to the theory of supply relationship and food safety management and confirms that the more collaborative and supportive supply chains significantly correlate to

high scores of FSMS activities at Vietnamese food firms. The higher in term of these aspects of quality of supply relationship, level of collaboration and external supports could lead to the higher the scores of FSMS activities of food firms. These results corroborate the findings of a great deal of the previous works (e.g. Kafetzopoulos & Gotzamani, 2014; Kirezieva et al., 2015b) in defining and recognising the impact of supply chain relationship on food safety management that is needed to investigate, understand and improve to gain more possibility of delivering safer food to consumers. Additionally, by using hierarchical cluster analysis, this study provides a closer look at significant differences between "best practice" firms and others in their supply relationship. These results could help firms who are having lower scores of FSMS to identify where is the problem in supply relationship and learn from others in the higher ranking cluster to improve. Therefore, the practical implication of this study could facilitate their managers to know where they are and provide the necessary resources, supports, and develop the appropriate policies, practices and procedures with their key suppliers to improve FSMS activities. Our findings can also inform other stakeholders, such as suppliers, government and authorities as well as business associations to further enhance their activities in supporting and collaborating exporting firms since managing food safety and quality as a shared responsibility of all actors in the food chain including governments, industry and consumers (FAO/WHO, 2001).

On the other hand, these findings may be somewhat limited by the nature of empirical research. First, 54 firms in only one single developing country (Vietnam) is a relatively small sample. The future research may be empirically conducted in a larger sample in different countries then more analysis techniques could be applied to explore the impact of supply relationship on FSMS activities and undertake comparative analyses on the performance of different FSMS between firms in these countries. Second, there is possible bias on behalf of quality managers or top managers in answering the research questionnaire. Thus, there is a need for further investigation with an on-site data collection or from diversity perspectives by recruiting multiple respondents, for example, food exporting firms' suppliers.

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