Journal of Business and Economics, ISSN 2155-7950, USA
October 2016, Volume 7, No. 10, pp. 1696-1703
DOI: 10.15341/jbe(2155-7950)/10.07.2016/012

http://www.academicstar.us

The Application of a Quality System for Poultry Production at SMEs in Thailand to Enhance Sustainable Competitiveness

Suphattra Ketsarapong[1], Prapapan Ketsarapong[2]
(1. Sripatum University, Thailand; 2. Kasetsart University Sriracha Campus, Thailand)

Abstract: The purpose of this research article is to present the development of an instrument called the Hazard Analysis and Critical Control Point (HACCP) to assure the safety and quality of food. It is applied in small and medium-sized enterprises (SMEs) in the poultry industry in order to improve competitiveness and to conduct business sustainably. HACCP was applied as the research methodology. For poultry production, there is a sequence of five steps: gap analysis and HACCP preparation, HACCP plan development, validation of the HACCP plan elements, HACCP implementation, and HACCP maintenance. The SMEs improved their system and provided training to achieve HACCP certification. It was found that the case study sales volume increased by about 50% in 2014 after applying HACCP compared to the previous year. The production cost was reduced by about 10%. By deploying HACCP, the case study enterprises could meet customer needs and expand their businesses by retaining existing and winning new customers in a modern trading group. The knowledge could also be applied in other factories, especially those in the poultry industry.

Key words: quality management; food safety; poultry production; HACCP; Thailand
JEL code: L6

1. Introduction

Hazard Analysis and Critical Control Point (HACCP) was developed for the first time in the 1960s when Pillsbury Corporation cooperated with The National Aeronautics and Space Administration (NASA) in order to guarantee the safety of food for astronauts (Bennet & Steed, 1999; Yunus & Ray, 2007). The HACCP system has been widely known at a national level from the end of the 1980s as a tool to guarantee food safety (Guzewich, 1985; Codex Committee on Food Hygiene, 1997; Kit & Patricia, 2008). The United States of America was the first country to develop an HACCP system which is acceptable to many international food-related authorities such as the International Commission on Microbiological Specification for Food (ICMSF), the International Association for Milk, the Food and Environmental Sanitarian (IAMFES) and CAC (Kvenberg et al., 2000). This has resulted in many countries around the world, for example Australia, Canada, the European Union, South Africa, China, Japan, South Korea, Singapore and Thailand, applying the HACCP system in their food industries (Peters, 1998, 1999; Hielm et al., 2006; Kok, 2009; Herath & Henson, 2010; Kimchangbong & Kim Kyu Hyong,

Suphattra Ketsarapong, Dr. Eng, Assistant Professor, Department of Mechanical System and Innovative Industrial Engineering, School of Engineering, Sripatum University; research areas/interests: industrial engineering. E-mail: suphattra.ke@spu.ac.th.
Prapapan Ketsarapong, Department of Industrial Engineering, Faculty of Engineering at Sriracha, Kasetsart University Sriracha Campus. E-mail: prapapan@eng.src.ku.ac.th.

2013; Yudi et al., 2015). Furthermore, food quality control systems are widely applied in Halal food companies. A survey in Malaysia showed that 67.2% of Halal food manufacturers in Malaysia apply HACCP systems, 32.8% of them apply ISO9001 and 19.7% of them apply ISO22000 (Malihe et al., 2013).

Therefore, it is evident that many countries around the world apply HACCP systems in their food manufacturers from SMEs to big manufacturers (Baines, 2004; Yapp & Fairman, 2006). It is also found that the HACCP system is applied in food safety management by food businesses for example hotels, restaurants, and in healthcare (Kivela et al., 2002; Griffith, 2006; Dimitrios et al., 2013; Hamidreza et al., 2015). Various researches have presented results of the application of HACCP systems, and there are a lot of advantages for business operations, especially SMEs. It is sustainable for their business operations due to various reasons: it elevates the food quality level; expands markets and customer groups; meets customers' expectations; can expand business into international markets; the production process complies with the law and business partners' requirements; and it reduces overall production cost and waste, and gives moral support to employees (Kit & Patricia., 2008; Kane, 2011). This research, therefore, has the objective to present the measurements for food safety control or HACCP to be applied to the (SME) poultry industry of Thailand in order to increase the competitiveness and sustainability of business operations, and to be a model for other manufacturers especially in the poultry industry group.

2. Case Study Background

The case study company is an SME, established in 2011 to operate poultry slaughterhouse businesses including the production and distribution of fresh chicken and frozen chicken for customers in Southern Thailand. This company started with a production capacity of 8,000 chickens/day and 80 employees, with fresh markets and Siam Makro PCL in the Southern zone as its main customers with a 3% market share. Under the business operation of this company in the next four years, by 2015, there were more than 140 employees, with a production capacity of 30,000-40,000 chickens/day and a 15% market share.

The company has the intention to produce safe, quality products in order to meet customer requirements by paying attention to every production process from hatchling and feeding to the farm (making contract with the farm), to the meat production process, up until frozen chicken delivery to the customers, as shown in Figure 1.

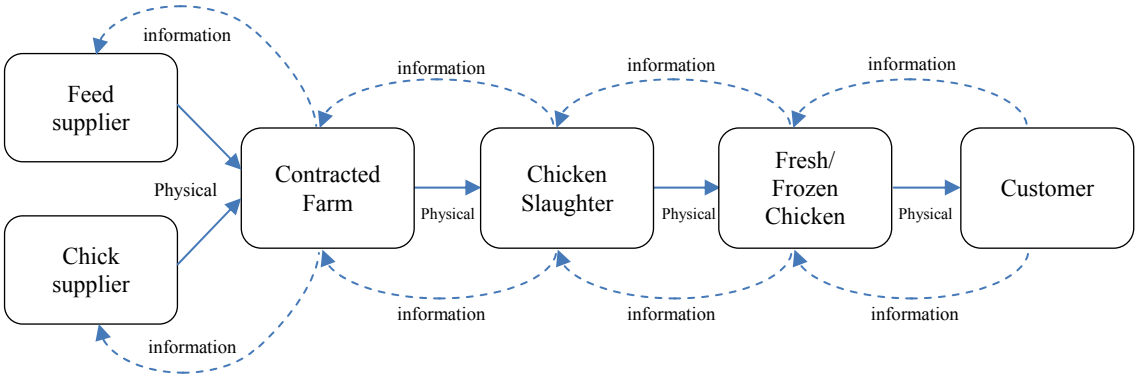

Figure 1 The Supply Chain of Chicken in the Factory Case Study

Furthermore, in order to have a good management system and to increase competitiveness, the executive of the company foresaw the significance of the application of the international food safety management system. The company was certified for Good Manufacturing Practice (GMP) in 2013 and prepared for the HACCP system at

the beginning of 2014. The company also foresaw the significance of production control and the process following the Islamic method, The Central Islamic Committee of Thailand, therefore, allows them to use the Halal mark on the product. The production process is presented in Table 1.

Table 1 Production Process and Detail

No.	Process	Detail
1	Reception of live chickens	Purchasing Department prepares the queue of the trucks delivering chickens to the slaughterhouse following the production plan.
2	Resting	Rest chickens for not less than 30 minutes to cool them down and reduce their stress in order to get good quality chickens and for the customer's safety.
3	Checking before bleeding	Check for diseases and make records for example the number of farms, average weight, chickens' condition, etc.
4	Hooking	Chicken are hooked on to the product conveyor belt whose speed is determined by the chicken's weight which is categorized into 3 classes: big size (2.3-2.5 kg); medium size (1.9-2.3 kg.); and small size (1.6-1.8 kg.)
5	Anesthesia	By electro narcosis. Chickens must be completely unconscious.
6	Bleeding	Proceed the bleeding following the Halal method.
7	Scalding	Pass chicken carcasses through the automatic boiler, controlling the water level at 200 liters and the temperature at 66°C-67°C for 40 seconds.
8	Plucking	By automatic plucker, taking around 35-40 seconds/round.
9	Evisceration	By evisceration machine.
10*	Cleaning the internal and external carcass	Chicken carcasses are passed through a water spray for cleaning at a water pressure of 2 bar, both internal and external.
11	Inspection of chicken carcass	Inspect the quality of chicken carcass: no features, abdominal organs, blood and gloves.
12*	Cooling	Chickens are put into the chiller for cooling. The temperature of the carcass must not be over 4°C.
13	Carving	Some chickens are packaged whole, the rest are carved as per the customer's requirement to be sold as a frozen product.
14*	Metal detection	Packaged chickens are passed through a metal detector.
15	Freezing	Chickens are put into the freezer not less than 13 hours. The temperature must not be below -35°C.
16	Boxing	After final inspection, chicken are boxed.
17	Keeping in the warehouse	The products are kept in the warehouse. The temperature must not be below -18°C.
18	Delivery	The delivery department delivers the products to the customers according to the plan.

3. Method

The research process consists of five main steps as shown in Figure 2: step 1 gap analysis and HACCP preparation; step 2 HACCP plan development; step 3 validation of HACCP plan elements; step 4 HACCP plan implementation; and step5 HACCP system maintenance. The process details are as follows:

3.1 Step 1 Gap Analysis and HACCP System Preparation

The research examines the company's current production process and quality system, and then makes the connection with the HACCP system and prepares the company to apply the HACCP system development consisting of 5 sub-steps: HACCP team appointment; preparation of product nature description; identification of product purpose and target consumers; flow diagram preparation; and on-site confirmation of the flow diagram. The process in this sub-step is in accordance with the preliminary codex steps as shown in Figure 2.

3.2 Step 2 HACCP Plan Development

The development of the HACCP plan includes 5 steps in accordance with the first to the fifth Codex Principles as shown in Figure 2.

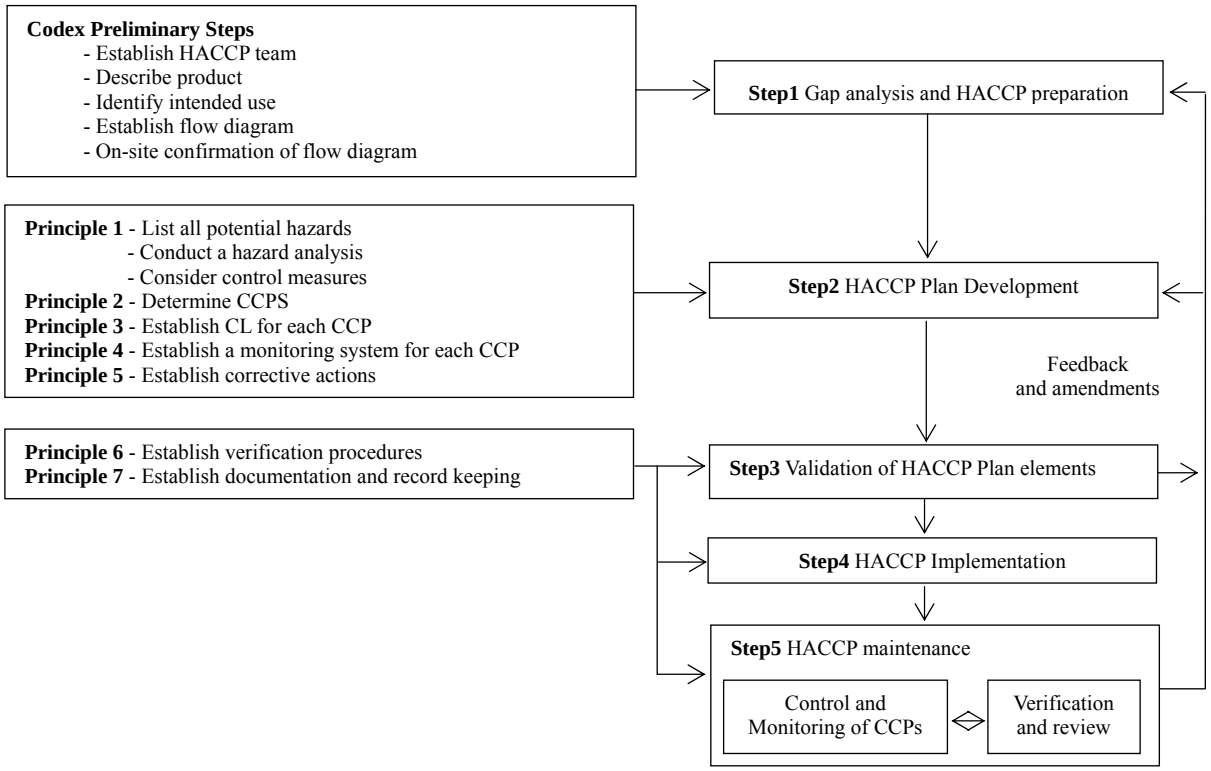

Figure 2 The Methodology Framework

3.2.1 Conduct Hazard Analysis: In Accordance with the First Codex Principle

Hazards that might occur in every production process will be analyzed as presented in Table 1 from the beginning process — the receipt of live chickens — to the final process — the delivery of fresh or frozen chickens to customers. The hazard analysis will also cover the part of live chickens from the farms and packaging. There are 3 types of hazard analysis: biological hazard; chemical hazard; and physical hazard. The hazard assessment will then be conducted by the method of risk analysis in this research, calculated from Severity (S) × Likelihood (L). The severity and likelihood have 4 levels: 1-4, ordered from least to greatest. The result is categorized into 4 levels as presented in Table 2 while the hazard control is categorized into 3 types as follows:

- Acceptable or satisfactory level — follow the practice of the GMP system
- Minor to major level — use a tool called the "Decision Tree" to make the decision as to whether to follow the HACCP plan to control the hazard or the practice of the GMP system
- Critical level — follow the HACCP plan by determining the Critical Control Point

Table 2 Evaluation of the Risk Level of Each Hazard

Risk Level (S X L)				
(Likelihood; L)	(Severity; S)			
	Negligible (1 score)	Low (2 score)	Medium (3 score)	High (4 score)
Negligible (1 score)	Satisfactory (1)	Satisfactory (2)	Satisfactory (3)	Satisfactory (4)
Low (2 score)	Satisfactory (2)	Minor (4)	Minor (6)	Minor (8)
Medium (3 score)	Satisfactory (3)	Minor (6)	Major (9)	Major (12)
High (4 score)	Satisfactory (4)	Minor (8)	Major (12)	Critical (16)

3.2.2 Determine the Critical Control Points (CCP): In Accordance with the Second Codex Principle

This is to determine the CCPs by applying the tool called the "Decision Tree" consisting of 4 questions as presented in Table 3.

Table 3 Questions to Determine the CCPs by Decision Tree

Question 1	Do control preventive measure(s) exist? If yes, go to Question 2.
Question 2	Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level? If yes, this is CCP. If no, go to Question 3.
Question 3	Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to unacceptable levels? If no, this is not CCP, keep going. If yes, go to Question 4.
Question 4	Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to an acceptable level? If no, this is CCP. If yes, this is not CCP. To answer yes, it must be certain that the hazard must be really controlled by the subsequent production process.

3.2.3 Establish the Critical Limit for Each CCP in Accordance with the Third Codex Principle

The steps to establish the critical limit, (CL) in each previously described CCP are as follows. The researcher set up a working team which included expert consultants together with the company's steering team. The CL value benchmarking is set up based on general cases in the literature, the regulations about food safety, customer requirements to ensure that the CL value complies with all requirements and is adequate. The research considers the parameters of CL that are measureable such as temperature, pressure, time, humidity, etc. and also the human sensory parameter, for instance, no metal or gloves are left in the product, no bruises on the chicken meat, etc. The results are described in the next part.

3.2.4 Establish a System to Monitor Control of the CCP: In Accordance with the Fourth Codex Principle

The monitoring plan on CCP critical limit control is conducted by checking the key parameters, such as the temperature, pressure, and humidity, and the observation of human sensory parameters such as no metal left in products (frozen chicken). These basic steps evaluate whether the Critical Limit values at the CCP point are under control or if they deviate from the control point. If the monitoring steps found that the CL deviates, the company needs to fix it by using What, How, When and Who questions to make sure that the monitoring process can recover to the set up CL. The results are described in the following part.

3.2.5 Establish the Corrective Action: In Accordance with the Fifth Codex Principle

Corrective action will be applied when the CL in the CCP deviated. The corrective action process is prepared in advance to assure that when the CL deviation occurs in the CCP, the process can fix the issue immediately to reduce the risk with regard to customer safety and product quality. This process will then establish the root causes that cause the deviation to make further improvements to prevent any repeats. The results are described in the next part.

3.3 Validation, Implement and Maintenance HACCP System

This section discusses steps 3, 4, and 5 to complete the HACCP cycle. Step 3, the validation of the HACCP plan requires validating the planned actions in each CCP to obtain evidence to ensure that the elements of the HACCP plan are effective. In the case study, the CL in each CCP was validated, for instance, checking on bacterial contamination and chemical residues in the products is certified annually by laboratory testing. Step 4 of the HACCP Plan Implementation implements the validated HACCP plan in the production process. The key topics are documentation, records and traceability. In the case study, the HACCP Plan manual was established and implemented, including the recording of key parameters such as temperature, pressure, and metal detection in each CCP. Lastly, step 5 HACCP System Maintenance includes 2 parts: the control, monitoring verification and

review of each CCP. The HACCP system is scheduled to be reviewed and approved by the board of management every year, which helps to company guarantee that the HACCP maintains a high level of effectiveness.

4. Results

The research results show that from the production process of the case study company presented in Table 1, there are 3 CCPs: CCP1 is at no. 10 — cleaning the internal and external carcass — the analysis shows that CCP1 contains a biological hazard caused by a microbe found in chickens which grew during the process; CCP2 is at no. 12 — cooling — the analysis shows that CCP2 contains a biological hazard caused by a microbe found in chickens which grew during the process the same as CCP1; and CCP3 is at no. 14 — metal inspection — the analysis shows that CCP3 contains a physical hazard caused by metal fractures from some tools such as knives or contaminated tools from each production process, which may reach the consumers if the detector is not operative. The summary of the potential hazards, control measures, critical limits, operational limits, monitoring, corrective action, related documents and records, and the auditor are presented in Table 4.

Table 4 CCP Analysis, Control Measure, Monitoring and Corrective Action

No. process CCP		CCP 1 No. 10 Cleaning the internal and external carcass	CCP 2 No.12 Cooling	CCP 3 No.14 Metal Detection
Potential Hazard(s)		Biological hazard (Salmonella spp., E. coli, S. aureus)	Biological hazard (Salmonella spp., E. coli, S. aureus)	Physical Hazard (Scrap Metal; Fe, Non Fe, stainless)
Control Measure(s)		- Control water pressure - Control volume of water	-Control temperature of carcass	-Control of the metal detector.
Critical Limit		- Water pressure = 2 bar - Chicken weight < 2.5 kg. using water >= 1.5 liter/ carcass - Chicken weight 2.5-4.0 kg. using water >= 2.5 liter/ carcass	- Temperature of carcass must not be over 4°C.	-No scrap metal is larger than required. As follows; Fe > 2.5 mm. (Diameter) Non Fe > 3.0 mm. (Diameter) stainless ≥ 4.0 mm. (Diameter)
Monitoring	What	- Water pressure - Volume of water	Carcass	Specimen
	How	- Check pressure - Check volume of water	Use a thermometer	Use Test Pieces
	When	Every Hour	Every Half-Hour	-Before operation - During operation (Every Hour) -After operation
	Who	Operator station	Operator station Head of QC	Operator station
Corrective Action(s)	How	1. Process - Hold Lot - Stop conveyor belt -Urgent Correction 2. Product - Hold Lot	1. Process - Stop chiller - Add ice to adjust the temperature -Check temperature of carcass must not be over 4°C. 2. Product - Hold Lot	1. Process - Test metal detector by - Test Pieces 2.Product - Hold Lot (torn bag, cleaning, and pass the metal detector again)
	Who	- Head of Slaughter - Operator station - Engineer	- Head of chiller - Head of QC	Operator station
Record(s)		Pressure Recording (I-BF-PD-033)	Temperature Recording (I-BF-QC-017)	Metal detector Recording (I-BF-PD-023)
Verify by		Head of Slaughter	Head of QC	Head of QC

After the application of the quality and food safety tools, or HACCP, throughout the food chain from the farm to delivery, the case study company gained a lot of advantages as follows:

- Increased sales volume from 20,000 chickens per day in 2013 to 30,000 chickens per day in 2014, or a 50%

increment. This growth rate is expected to continue into the future;

- Production costs reduced by 10% due to the reduction of the reworking process, defects, overtime, energy, etc.
- Customer requirements were met as indicated by a reduction in customer complaints. Currently there are no complaints regarding quality and food safety;
- The market has expanded by maintaining existing customers but at the same time increasing the number of new customers in modern trade groups, as well as having the potential to expand into international markets in the near future such as Malaysia, China, and Myanmar;
- Employees in the company improved morale and confidence as a result of the safe process, the quality products and customer safety;
- There were more advantages for the supply chain (farms, manufacturers and customers), as a result of skill development and knowledge exchange.

5. Conclusion and Discussion

In conclusion, this research has the objective to present measurements for food safety control or HACCP to be applied in the (SME) poultry industry of Thailand in order to increase the competitiveness and sustainability of business operations, and to be a model for other manufacturers especially in the poultry industry group. The study described the steps to apply the HACCP in the general case and the application to the case study by following 5 steps: gap analysis and HACCP preparation, HACCP plan development, validation of the HACCP plan elements, HACCP implementation, and HACCP maintenance to achieve the HACCP qualification. In addition, there is a better understanding of the importance of determining the Critical Control Points (CCP) by establishing a critical limit for each CCP in the case study. Nowadays, food safety and quality are key to the success of the business because customers have pushed for a standardized system. Therefore, HACCP certification is a prerequisite for the food industry. The SMEs who need to survive the competition and win new customers need to acquire HACCP certification. For instance, the case study company increased their sales from 20,000 chickens per day in 2013 to 30,000 chicken per day in 2014. In addition, businesses can reduce their operations costs by reducing waste such as the defect rate, the reworking process, overtime pay, energy consumption and customer complaints.

Moreover, the company acquired greater value from their trained human resources through skills, experience and knowledge about the importance of HACCP. However, the implementation of HACCP involves more cost, for example, to renovate the production line, the prevention of cross contamination, the investment in machines that prevent CCP, the consultant expenses for acquiring HACCP certification, the training cost for human resource development especially coaching to enhance competence in food safety, as well as the cost of HACCP system certification. Therefore, in the trade off of these investments, the company has increased sales revenue after certification and their culture is prepared for further standard systems such as ISO22000 and BRC which matches future customer needs.

The future study areas that can be researched include the following:

- Comparison of standard systems for instance GMP, HACCP, ISO9001, ISO22000, BRC (British Retail Consortium) that are applied in the food industry especially poultry production at SMEs and throughout the supply chain.
- The development of appropriate tools that are suitable for the industry to help in CCP risk assessment

especially in poultry production SMEs.

- Database development in CCP and CP assessment in various industries to provide insights and for future reference.

References

Baines M. R. L. (2004). "Globalization: A study of the poultry meat supply chain", *British Food Journal*, Vol. 106, No. 10/11, pp. 819-836.

Bennet W. L. and Steed L. L. (1999). "An integrated approach to food safety", *Quality Progress*, Vol. 32, pp. 37-42.

Carol A. Wallace, Susan C. Powell and Lynda Holyoak (2005). "Development of methods for standardized HACCP assessment", *British Food Journal*, Vol. 107, No. 10, pp. 723-742.

Codex Committee on Food Hygiene (1997). "HACCP system and guidelines for its application: Food hygiene basic texts", Food and Agriculture Organization of the United Nations, World Health Organization, Rome, pp. 33-45.

Dimitrios Kafetzopoulos, Katerina Gotzamani and Evangelos Psomas (2013). "Quality systems and competitive performance of food companies", *Benchmarking: An International Journal*, Vol. 20, No. 4, pp. 463-483.

Griffith C. (2006). "HACCP and the management of healthcare associated infections: Are there lessons to be learnt from other industries?", *International Journal of Health Care Quality Assurance*, Vol. 19, No. 4, pp. 351-367.

Guzewich J. (1985). "HACCP for food service", *Journal of Food Protection*, Vol. 48, pp. 915-916.

Hamidreza T., Ali Z., Seyed A. K., Taha N., Leila K. and Nooredin D. (2015). "Status of prerequisite programs for implementation of HACCP system in chain restaurants in Iran", *British Food Journal*, Vol. 117, No. 6, pp. 1753-1763.

Herath D. and Henson S. (2010). "Barriers to HACCP implementation: Evident from the food processing sector in Ontario, Canada", *Agribusiness*, Vol. 26, No. 2, pp. 265-279.

Hielm S., Tuominen P., Aarnisalo K., Raaska L. and Maijala R. (2006). "Attitudes towards own-checking and HACCP plans among Finnish food industry employees", *Food Control*, Vol. 17, No. 5, pp. 402-407.

Kane K. (2011). "Evolving methods of HACCP: costs and benefits", *Worldwide Hospitality and Tourism Themes*, Vol. 3, No. 5, pp. 413-421.

Kimchangbong and Kim Kyu Hyong (2013). "An empirical study on the causal relation of supply chain traceability, transparency, sharing information, performance in HACCP of the Korean food industry", *International Commerce and Information Review*, Vol. 15, pp. 47-68.

Kit Fai Pun and Patricia Bhairo-Beekhoo (2008). "Factors affecting HACCP practices in the food sectors: A review of literature 1994-2007", *Asian Journal on Quality*, Vol. 9, No. 1, pp. 134-152.

Kivela J., Ling Lam M. and Inbakaran R. (2002). "Food safety in school catering in the people's Republic of China", *International Journal of Contemporary Hospitality Management*, Vol. 14, No. 6, pp. 301-312.

Kok M. S. (2009). "Application of food safety management systems (ISO 22000/HACCP) in the Turkish poultry industry: A comparison based on enterprise size", *Journal of Food Protection*, Vol. 72, No. 10, pp. 2221-2225.

Kvenberg J., Stolfa P., Stringfellow D. and Spencer G. E. (2000). "HACCP development and regulatory assessment in the United States of America", *Food Control*, Vol. 11 No. 5, pp. 387-401.

Malihe M., Mohd N., Nizaroyani S. and Che Rosmawati Che Mohd Zain (2012). "Lean supply chain practices in the Halal food", *International Journal of Lean Six Sigma*, Vol. 4, No. 4, pp. 389-408.

Peters R. E. (1998), "The broader application of HACCP concepts to food quality in Australia", *Food Control*, Vol. 9, pp. 83-89.

Peters R. E. (1999). "Developing and implementing HACCP certification in Australia", *Food Control*, Vol. 10, pp. 307-309.

Yapp C. and Fairman R. (2006). "Factors affecting food safety compliance with small and medium-sized enterprises: implications for regulatory and enforcement strategies", *Food Control*, Vol. 17, pp. 42-51.

Yudi Fernando, Hooi Huang Ng and Tim Walters (2015). "Regulatory incentives as moderator of determinants for the adoption of Malaysian food safety system", *British Food Journal*, Vol. 117, No. 4, pp. 1336-1353.

Yunus K. and Ray C. (2007). "Impact and status of HACCP in the Australian meat industry", *British Food Journal*, Vol. 109, No. 5, pp. 343-354.