Seafood supply chain quality management
Loc, V.T.T.

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Chapter 2

Literature Review

2.1 Introduction

Global consumers nowadays are more concerned about the safety of their food because of a series of food scandals and incidents that have occurred over the last decade and that see no signs of decreasing. The solution they call for is high food quality and integrity, safety guarantees and transparency. Governments are imposing new legislation; retailers are making new demands on their supply chains. Food supply chains are reacting by implementing systems to improve their product quality in an attempt not only to guarantee the safety of the products, but also to raise the consumer community’s awareness of their efforts. Such efforts are performed at the level of either an individual company or a complete supply chain network (Van Dorp, 2004; Beulens et al., 2005). Food safety (FS), therefore, is currently considered to be an important issue for all stakeholders in the area of food production as well as governments in setting new legislation regarding FS.

Quality control has become a cornerstone of food safety policy over the past decade in the food industry. Much of the focus has been on integral quality management systems. These systems include all steps in the food production chain, such as supply of raw materials, food manufacturing, packaging, transportation and logistics, research and development, maintenance of production equipment, and training and education of staff. Moreover, “Food quality is associated with a proactive policy and the creation of controls to maintain a safe food supply. The business community in the food supply chain regards the call for safety from their customers, consumers, government and other stakeholders as an important driving force for continuous innovation. These innovations have been focused on implementing systems to improve the product’s quality, to guarantee its safety as well as to raise awareness of these innovations throughout their supply chain stakeholders.” (Folstar, 2001)
One of the important tools used to ensure food safety against hazard infections is the HACCP system. According to Sperber (2005), HACCP was begun as a voluntary science-based system within the food industry and it helps provide greater transparency in the food supply chain. The application of HACCP systems is a means of assuring proper food handling, processing and retail sale to consumers. The use of HACCP systems in the fishery industry is now global. Since it first emerged, the concept has increased in importance through its endorsement by Codex Alimentarius at the international level and by the EU and the US, two of the most important seafood importers. Currently, over forty countries have announced HACCP initiatives for the control of fish production, processing and distribution.

Although quality control in general and HACCP in particular have been used in manufacturing industries for decades, they are clearly ineffective and almost totally incapable of detecting food safety defects that occur at a low incidence (ICMSF, 2002). Coming out with detailed proof of this is Sperber (2005), who reports that the global use and success of the HACCP system in the food processing industry has created a false expectation that it could be used successfully in all steps of the food supply chain. However, this is not necessarily true. There has been a lack of defining of critical control points (CCPs), which have the function of eliminating or controlling identified hazards. As a result, there is no effective use of HACCP in all steps of the supply chain. In order to ensure food safety in the supply chain, it is necessary to combine prerequisite programs along with HACCP, rather than only CCPs taken from an HACCP system.

In other words, in order to ensure food chain supply safety, a combination of HACCP implementation and other prerequisite programs is vital throughout the chain. The reasons for such an emphasis (Billy, 2002; Motarjemi & Mortimore, 2005) lie in the fact that the food industry is today not only responsible for ensuring the safety of food production through various measures aimed at safeguarding against its hazards (i.e., the hazards which have been considered in production and the measures put in place to ensure the safety of products), but it is also responsible for the development of further HACCP studies as a part of the food safety assurance system. Thus, the HACCP tool and prerequisite programs play an important role in supply chain FS from “farm to table,” especially in both raw and ready-to-eat food products. In addition, the implementation level of HACCP and other prerequisite programs is different from country to country according to each country’s own conditions. But to achieve FS objectives and promote international trade effectively and efficiently, the role of government and industry is crucial in terms of setting performance quality standards, regulatory issues, implementation of inspection and audit as well as risk assessment throughout the whole chain.
Generally, the greatest constraints on the implementation of HACCP and prerequisite programs in developing countries are the limitations of managerial knowledge and technological investment within the food companies. These limitations are especially big challenges for SFCs in Vietnam in general, and in the MD in particular, in the effort to ensure supply chain seafood safety. Therefore, food quality control through the techno-managerial approach in the food chain is a useful approach used to solve the research problem in this study.

To conclude, the literature to review here has to do with not only the role of HACCP itself in food safety assurance, as well as the combination of HACCP and other prerequisite programs, but also the role of governments and industries, the techno-managerial approach, and the food supply chain quality and quality management in developing countries.

2.2 The role of HACCP in ensuring food safety

2.2.1 The HACCP system

The grounds for the development of the HACCP system stem from the pathway to the HACCP system started in 1959 when Pillsbury was asked to produce a food that could be used under zero gravity conditions in space capsules – food products for space use should not be contaminated with any bacterial or viral pathogens, toxins, chemicals or any physical hazards that could cause an illness or injury. At that time, most food safety and quality systems were based on end-product testing, but it was realized that this could only assure product safety through testing 100% of the products which, for obvious reasons, was not workable, since it would result in all products being used up. Instead a preventive system was required which would give a high level of food safety assurance. However, the implementation of HACCP approach is not easy to apply completely in the entire chain, particularly during primary production. As a result, importing countries are still rejecting products due to infection hazards.

What follows are summaries of the definitions and content of HACCP, HACCP principles and procedures, and the legal impact of HACCP.

2.2.1.1 HACCP definitions and contents

HACCP is defined by many authors. Some definitions refer directly to food safety, reflecting the predominant use to date of the HACCP approach in the food sector. Other definitions are more generic: a step-by-step approach to the identification and assessment of hazards and risks associated with the manufacture, distribution, and use of products. For instance, HACCP is defined as a systematic approach to the identification, assessment and control of hazards (McDonough, 2002). It is widely accepted as being the most effective means of ensuring food safety because HACCP is a management tool used to protect the
food supply against microbiological, chemical and physical hazards. In other words, HACCP is a system for identifying, evaluating and controlling the hazards in food manufacturing, which are crucial for product safety. It is also an analytical tool that enables management to introduce and maintain a cost-effective, ongoing food safety program. Peirson (1995) stresses that HACCP has been strongly suggested as an effective approach to prevent food safety hazards by many national and international scientific groups, corporations, government agencies and academic organizations.

In other words, HACCP is a proven system, which if properly applied will give confidence that food safety is being managed effectively. And HACCP is also a preventive system in quality control. The system when properly applied can be used to control any area or point in the food system that can contribute to the hazardous situation, whether it be contaminants, pathogenic micro-organisms, physical objects, chemicals, raw materials, a process, directions for use by the consumer, or storage conditions. Similarly, as Lackova (2001) has it, the HACCP is a tool which can integrate all elements of production, storage, distribution, and the preparation of food. And the control points can be used as inescapable measures to provide hygienic standards and health safety. The basic objectives of the HACCP concept are to assure the production of safe food products by prevention instead of by quality inspection (Leaper, 1997; NACMCF, 1998). Furthermore, the HACCP is basically designed for application in all parts of agri-food production, ranging from growing, harvesting, processing, manufacturing, distribution, and merchandising to preparing food for consumption (NACMCF, 1998).

The concept “hazard” in the HACCP terminology is expressed in terms of a danger to food safety from a biological, chemical or physical point of view. The term “hazard” refers to any part of a production chain or a product that has the potential to cause a safety problem. Analysis is the identification and assessment of the seriousness and likelihood of occurrence of a hazard. A critical control point is a point, step, or procedure at which control can be exercised to prevent, eliminate, or minimize a hazard. In the HACCP system specific dangers are identified all along the lifetime of a food product and the measures to manage (or control) these dangers.

- Biological hazards can be further divided into three types: bacterial, viral, and parasitic (protozoa and worms). Brown (1995) mentions methods for Microbiological quality assurance. Especially HACCP system. Many HACCP programs are designed specifically around the microbiological hazards. Archer and Kvenberg et al. (2000) estimates that the incidence of foodborne illness ranges from 12.6 to 81 million cases per year with hazard costs of 1.9 to 8.4 billion dollars. HACCP programs address this food safety problem by assisting in the production of safe wholesome foods.
• **Chemical hazards**: Webster defines a hazard chemical as any substance used in or obtained by a chemical hazard process or processes. All food products are made up of chemicals, and all chemicals can be toxic at some dosage level. However, certain hazardous chemicals are not allowed in food and others have had allowable limits established. A summary of most of the chemical hazards in food has been drawn up (Bryan, 1984). The two types of chemical hazards in food are naturally occurring ones and added chemicals. Both may potentially cause chemical intoxications if excessive levels are present in hazardous food. For additional information, see Foodborne Diseases (Cliver, 1990). Many HACCP programs have been criticized for their relative neglect of chemical and physical hazards.

• **Physical hazards**, often described as extraneous matter or foreign objects, include any physical matter not normally found in food, which may cause illness (including psychological trauma) or injury to an individual (Corlett, 1991). The most often reported complaint concerning physical hazards is that foreign objects provide tangible evidence of hazard product deficiency. Regulatory action may be initiated when agencies find adulterated foods or foods that are manufactured, packed or held under conditions whereby they may have become contaminated and may be injurious to health.

The hazard analysis portion of HACCP involves a systematic study of the ingredients, the food product, conditions of processing, handling, storage, packaging, distribution, and consumer use. This analysis helps to identify the sensitive areas in the process flow that might contribute to a hazard. This information can then determine the CCPs in the system that have to be monitored. A CCP is any point in the chain of food production from raw materials to finished product where loss of control could result in an unacceptable food safety risk.

### 2.2.1.2 HACCP principles and procedures

Several articles have described HACCP principles and procedures for the development and implementation of an HACCP plan (ICMSF, 2002; European Commission, 1996; Early, 1997; Leaper, 1997; NACMCF, 1992, 1998; Buchen, 1990; Bryan, 1990; Bjerklie, 1992). According to them, an HACCP plan is a written document based on the principles of HACCP and delineates the procedures to be followed. The HACCP consists of seven principles and is implemented in a 12-step procedure (see Appendix 6 for details), which outlines how to establish and implement an HACCP plan for the operation. The HACCP principles have international acceptance and details of this approach have been published by the Codex Alimentarius Commission (1993, 1997) the European

- Assembling an HACCP team
- Description of the product and its distribution
- Identification of intended use and consumers
- Development of process flow diagrams
- On-site verification of flow diagram
- A hazard analysis, which involves collecting and evaluating information on hazards associated with the food under consideration to decide the significant hazards to be addressed in the HACCP plan (Principle 1).
- Determination of critical control points (CCPs), which are steps where controls can be applied and are essential in order to prevent or eliminate or reduce a hazard to an acceptable level (Principle 2).
- Establishing critical limits, which are maximum/minimum values at which a biological, chemical, or physical parameter must be controlled at a CCP (Principle 3).
- Establishing monitoring procedures to assess whether a CCP is under control and to create an accurate record for future use in verification (Principle 4).
- Establishing corrective actions, in case there is a deviation from an established critical limit (Principle 5).
- Establishing verification procedures to verify that the HACCP system is working correctly (Principle 6).
- Establishing record-keeping and documentation procedures to document the HACCP system (Principle 7).

2.2.1.3 **HACCP legal impacts**

HACCP has been and is being mandated into law in many nations all over the world. The EU, for instance, has adopted HACCP through the Directive 93/43 since 1993 (Ziggers, 2000), and is preparing new policies, regulations and laws (Van Plaggenhoef, Batterink & Trienekens, 2003). In the US, HACCP was mandated for seafood in 1995, for meat and poultry in 1998, and for the juice industry in 2001 (FDA, 2001). The Australian Food Standard Code required HACCP-based food safety programs from January 2003 onwards (Food Standards Australia New Zealand, 2002). In New Zealand, the Animal Products Act 1999 required all primary animal product processing businesses to have an HACCP-based risk management program in place by November 2002. Generally, the effects of the legislation on HACCP not only help food chain stakeholders, but also individuals and customers, and all have responsibilities for the successful implementation of food safety programs in both developed and developing countries.
According to Cao et al., (2002), as HACCP is increasingly used as a food safety assurance program, concerns have been put forward about its effectiveness in enhancing food safety as well as on the impacts it may have on food markets, industry, and consumers. They also discuss issues associated with the adoption of HACCP and its impacts, which include: (1) HACCP as food safety regulation; (2) benefits and costs of HACCP; (3) impact on market structure and in the distribution of regulation costs; and (4) HACCP as an international trade standard (see Part C, Appendix 6 for details).

2.2.2 HACCP and other prerequisite programs

As mentioned in Section 1, HACCP is a necessary, but not a insufficient, condition for ensuring food supply chain safety. What that means is that HACCP cannot be effective when applied as an isolated system. It must be supported by prerequisite programs (Sperber, 2005). Therefore, each company is required to have its own HACCP plan tailored to its individual products and required prerequisite programs prior to the implementation of HACCP. Prerequisite programs, such as Good Manufacturing Practices (GMP) and Standard Sanitary Operation Procedures (SSOP) are an essential foundation for the success of an HACCP plan (NACMCF, 1997). GMP is standard guidelines set out by the FDA to ensure drug development is carried out in safe and quality processes, to avoid contamination and ensure repeatability. GMP to ensure that the products produced meets specific requirements for identity, strength, quality, and purity. SSOP is applied to all processing areas, equipment, utensils, storage and parameter areas that require wet or dry cleaning and sanitizing or verification as under HACCP on known schedules that are validated through inspections, monitoring and testing recordkeeping protocols. Besides, SQF (Safe Quality Food) and BRC (British Retail Consortium) standards have relation to HACCP and food safety. The SQF (Safe Quality Food) provides the food sector (primary producers, food manufacturers, retailers, agents and exporters) a food safety and quality management that is tailored to requirements of food safety and commercial quality criteria in a cost effective manner. BRC is used for all food stuff companies producing private brand products as well as for food industry organizations selling to Great Britain and being urged by British food chains to provide evidence of fulfilling their requirements regarding product safety, quality and legality.

Huss and Ryder (2003) indicate that it is important to point out that the prerequisite program certainly relates to safety and therefore is an essential part of a total quality control program. Thus part of a prerequisite program (e.g., sanitation controls) must lend itself to all aspects of a CCP, such as establishing critical limits, monitoring, corrective actions, record keeping, and verification procedures. Practical experience has shown that if the general issues related to the prerequisite program are dealt with first, the HACCP study will be much more straight forward and the resulting HACCP plan easier to manage. All
issues related to hygiene programs applied to all processing areas, equipment, utensils, storage, and parameter areas will be dealt with in the prerequisite program. It is noted that the prerequisite program is a good starting point for companies who have a long way to go towards implementing an HACCP system. In addition, food safety failures are both failures of HACCP implementation and of cleaning and sanitation practices or a lack of management awareness of and commitment to providing the necessary training and resources. That is why the HACCP cannot be effective when applied as an isolated system. It must be supported by prerequisite programs. It is suggested that appropriate prerequisite programs must be paid attention to and applied at each step in the whole chain. Similar attitudes were mentioned in the studies of Mortimore (2001); Panisello and Quantick (2001), and Motarjemi and Mortimore (2005). As far as the above reasons are concerned, Sperber (2005) indicates that it is better to focus on the application of effective food safety control measures because “Farm to Table Food Safety” (combination of HACCP and prerequisite programs) is better communication than “Farm to Table HACCP” (only HACCP applied).

In many countries, the implementation of prerequisite programs is a necessary condition in order to achieve an HACCP certificate. They refer to measures and requirements which any establishment should meet to produce safe food. In other words, HACCP ensures food safety through an approach that builds upon foundations provided by GMP/GHP. The combination of GMP, SSOP and HACCP is particularly beneficial in that the efficient application of GMP and SSOP allows HACCP to focus on the true critical determinants of safety. However, according to the regulations of each country GMP/GP (most developed countries) or both GMP and SSOP (developing countries like Vietnam, Thailand, Bangladesh) are used as the prerequisite programs.

In short, HACCP is a system, which ensures food safety through preventive measures. It is very effective in controlling identified hazards. Most importantly, it relies upon product design and process control not product testing to ensure food safety. Food safety is based upon the principles of preventing food safety problems (HACC) and on prerequisite programs. To do this, it is necessary to ensure that both the food industry and government are carrying out appropriate roles and responsibilities as well as setting regulatory activities to control food safety risks. In other words, HACCP is a necessary, but insufficient, condition for assuring food safety. Food safety consists of an HACCP system and other prerequisite programs throughout the whole supply chain. Hathaway (1999) and Stewart et al. (2002) made similar definitions. An HACCP system can be effective only if it is based on GMP/GHP. Consequently, it is the responsibility of government agencies to ensure that these prerequisite programs are implemented before assessing HACCP implementation in the food companies.
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Implementation of the HACCP program produces the following benefits:

- HACCP offers enhanced safety
- HACCP focuses on essential factors, allows for a better use of resources and is cost-effective
- HACCP, specific and flexible, provides a more timely response to safety problems
- HACCP is informative for those involved in its implementation
- HACCP provides an appropriate answer to product liability
- The principles of HACCP can also be applied to other quality attributes
- HACCP can aid control by regulatory authorities
- HACCP can promote international trade by increasing confidence in food safety

2.3 The role of government and industry in food safety assurance

Food safety experts from Asia (India, the Philippines, Thailand), Africa (Morocco, Burkina Faso, Ghana, Mauritania, Senegal), Latin America (Brazil, Costa Rica, Guatemala), and representatives of France, Germany, the United Kingdom, WB, FAO, WHO, and members of the European research community emphasize that food quality control cannot be applied successfully in each country without the support of government and industry (Hanak et al., 2002).

Kvenberg et al. (2000) discuss the role of the government and the industry in ensuring food safety. The government’s responsibility is (i) to mandate the regulatory requirements for HACCP implementation; (ii) to establish mandated critical limits when necessary; (iii) to establish criteria, methods and sampling plans when necessary; and (iv) to verify that in individual facilities HACCP plans are adequate in order to assure food safety. Additional government activities should be to use epidemiological and scientific data to identify hazards and conduct risk evaluations. The evaluation results aim to provide information which can be used to improve HACCP plans; support research relating to CCPs, critical limits, and monitoring procedures; cooperate with interested groups in identifying new food safety hazards and identifying strategies for their control; encourage and participate in educational programs to promote the use of HACCP; cooperate with industry in the development of generic HACCP plans; and, finally, exercise whatever actions are deemed necessary to prevent unsafe food from reaching consumers. In terms of industry responsibilities, the industry must develop, implement, and maintain an effective HACCP system, with each facility forming an HACCP team that is responsible for the HACCP plan.
As an example of the implementation of a governmental role, Hanak et al. (2002) mention that the government in the UK appears to play a crucial role in developing policy, promoting legislation, and implementing EU legislation. The role lies mainly in the Ministry of Agriculture, Fisheries and Food (MAFF) and the Department of Health (DoH), along with the Scottish, Welsh and Northern Ireland Offices. Specifically, MAFF has an important role to play in promoting the economic interests of the agriculture, fishing and food industries and this is particularly valuable in the international arena. In Canada, an important feature of the food safety system is the respective roles of the Federal and ten Provincial governments. If meat, poultry or seafood is to be moved inter-provincially or exported, Federal government regulations apply. The annual report of the Auditor General of Canada released in Nov. 1999 was sharply critical of the lack of coordination between Provincial governments and other relevant institutions in responding to a nationwide salmonella outbreak in 1998. Under the Australian constitution, State governments are responsible for the enforcement of food law, with that responsibility extending back to the farm, development of national food standards for further processing, distribution and retail (Jill et al., 1999).

Some aspects that the government, according to Hanak et al. (2002) and Jill et al. (1999), can support are: quality control programs, training, research, role of consultant, as well as logistical supports. Billy (2002) also adds that industry and government have a very important role to play in the implementation of FS by setting standards for food safety and other consumer protection concerns.

According to Billy (2002) and Suwanrangsi (2000), although many food companies have excellent HACCP programs, they need to improve their performance in conducting hazard analyses, reassessing their plans, and validating the measures they adopt in addressing those hazards because there are many gaps and deficiencies in HACCP implementation. Therefore, discovering areas where improvements are needed, such as in risk management, infrastructure and resources, communication, training and education and workplace environment, are all crucial. As noted by Ababouch (2000), the HACCP principles play a pivotal role in preventive approaches. Their application is the responsibility of the food industry, whereas the government control agencies are responsible for monitoring and assessing their proper implementation. The responsibility of the government inspectors is to ensure that the HACCP program used by the food processor is properly designed and properly implemented. In this respect, assessment of the HACCP program can be done in two steps. First, an assessment of the HACCP manual which is basically a document review. Second, an on-site verification to establish whether the approved HACCP manual is properly being implemented.

Regarding the industry role, several countries are exploiting the possibility of privatization of elements of hygiene inspection (especially in the meat, poultry and seafood sectors) and this requires different legislation and infrastructure as
compared with traditional programs. Traditionally, the industry has had the primary responsibility for GMP-based process control, and now it has the primary responsibility for HACCP-based process control (Lee & Hathaway 1999). Moreover, to Motarjemi and Mortimore (2005), there are many measures that the food industry can use to manage food safety in a more efficient manner and reassure public confidence in the food supply. Such measures include regulations and policies, guidance on hazards, risk communication and education, incidents and crisis management. Industry needs to revisit its approach to training, to recognize that we have different levels of maturity, to make improvements at the primary production levels. Primary production is at the start of the food chain and perhaps too little attention has been focused in this area. Although much has been done in the last few years, much remains to be done. Although we are not operating to common standards worldwide, agricultural practices in the industrialized countries may be used to help developing countries.

Governments in the developing world face multiple demands and have a limited capacity to respond. In light of governments’ own resource constraints, donor agencies play a key role in improving developing country food safety management (Hanak et al., 2002). Regarding fish exports, there are two impacts from developing countries. Positive impacts are anticipated to be a strengthening of ties between government and industry regarding fish quality, a stronger commitment to improve fish quality, adoption of safety and quality improvement programs such as HACCP, and more training and education in quality and fish inspection processes. Negative aspects are lack of trained personnel, lack of financial resources, lack of communication between inspection authorities and lack of clear instructions from the importing country on conditions that must be met (Santos et al., 1993).

Some problems have been identified in some countries as reported by Marthi (1999), who finds that the Indian FS challenge is a mirror of the situation in most of the developing nations. Food industry professionals and government regulators must take due cognizance of this fact. Government, Industry, Academia and the community will meet to work closely, together with international agencies, in order to develop the most effective food safety regulations. In fact, there was a lack of adequate infrastructure for handling large scale food processing. A key issue is development of effective cold chains, given the high ambient temperatures and significant variability in power availability. Bangladesh also reported managerial problems that have caused micro-bio contamination, such as salmonella in frozen shrimp and prawns. To overcome these problems, both industry and government made major investments in more modern companies, laboratories and personnel trained in HACCP procedures (Unnevehr, 2000).
Even though the HACCP concept is one of the most effective and efficient ways of enhancing food safety, food industries in developing countries should be aware that it will not give complete protection even under the best conditions. This is another constraint: processors must be ever vigilant and prepared to act if any breakdown in standards is detected (Jirathana, 1998). To comply with the requirements of export markets, developing countries’ national governments have developed quality control systems to sustain their exports. In many developing countries, where food firms’ quality control systems are not well developed or implemented, both practice and attitude is that inspection and quality certification for export are the responsibility of the government (Zaibet, 2000).

As a conclusion of this section, for Fearne (1999) the food industry has a vested interest in supplying better information along the length of the supply chain. Governments have both a duty and a vested interest in facilitating the process. Besides support from the government, the food supply chain itself, which consists of production, from processing to marketing, should be supported by the food industry, support organizations, local departments and other chain stakeholders in order to achieve product quality control objectives. Furthermore, Suwanrangsi (2002) notes that the interaction between provincial government agencies and the fisheries industry is vital for promoting the sector’s development through the introduction of new technologies, extension, research, training, regulation and inspection. Finally, McDonough (2002) also concludes that the HACCP experience shows that government has a role to play in its successful introduction, and that this can be a challenging undertaking for all parties concerned.

2.4 Current situation of HACCP implementation in the world

2.4.1 HACCP and international trade

Changing consumption patterns for food, as well as changing global trade practices, can make huge impacts on food safety and risk assessment. Several countries have either mandated or are considering mandating HACCP requirements into their national legislation and they are specific in their HACCP requirements for particular sectors of their domestic food industries. The expectation is that exporting countries will meet the same requirements for internationally traded foods (Hathaway, 1999). In particular, the introduction of HACCP-based regulations for fish and fish products, particularly in the EU and the US, has triggered the need for production under the HACCP system in most fish exporting countries. It is reported that approximately 60% of the international fish markets require that fish and fish products are processed under HACCP systems, of which the EU and the US account for 50%, while Japan at 34% has not yet required HACCP compliance (Lupin, 1999).
Van Veen (2005) also argues that participation in global trade means that countries have to live by international rules and to consider major investments in food safety promotion and monitoring. Especially, chain partners of producers need to have a common standard/policy to ensure the quality and safety of products and to guarantee social acceptance.

By 1990, HACCP had become the primary approach for ensuring the safety of the food supply (Buchanan, 1990). Since then, there has been considerable effort to harmonize the use of HACCP by national and international institutions and to manage food safety hazards in the food industry worldwide (Panisello & Quantick, 2001). Besides, HACCP is intended to address hazards which are of such a nature that their elimination or reduction to acceptable levels is essential for the production of safe foods (Orriss & Whitehead, 2000). Furthermore, for Gillespie et al. (2001) the effectiveness of the HACCP system is evidenced by a better microbiological quality of food originating from small establishments with HACCP in place than from those without. Therefore, many governments have taken a risk assessment approach to ensuring the safety of the food supply and have mandated the use of an HACCP system in food industries (Unnevehr & Jensen, 1999; Ropkins & Beck, 2000).

Lee and Hathaway (1999) mention that “food exporting countries are now inextricably bound to comprehensive HACCP-based food control systems if they are to effectively assure the safety of food in international trade, and meet the market access requirements of an increasing number of importing countries. It remains the primary responsibility of industry to develop, implement and maintain HACCP systems. The supporting role of the regulator should be to enact supporting legislation, facilitate scientific design, ensure consistent applications, and verify the integrity of HACCP systems on a national basis. Further, continuous government effort is needed to improve the knowledge base relating to emerging hazards such as E.coli O157:H7 and thereby improve the ability of HACCP plans to meet specific public health goals. As new scientific approaches to HACCP evolve and risk assessment improves, bilateral and multilateral recognition of the legitimacy of different approaches to the design of HACCP plans in different countries is becoming a critical issue for food in international trade”.

Therefore, there is a need to close the wide gap between developing and developed markets in terms of knowledge and quality of institutions. Above all, to profit from the emerging opportunities, chain partners in developing countries and emerging economies must shift from an internal product orientation to an external market orientation. For instance, adapting HACCP systems and audits to suit local conditions in developing countries and also help in formulating HACCP for niche products exported from developing countries. Moreover, avoiding any confusion through the introduction of obligatory competing or overlapping multiple requirements, such as a mix of HACCP, BRC or SQF
(Safe Quality Food), may make sense in well-organized western markets, while the costs of such a mix may be prohibitive for small countries and small traders. A perception of excessive documentation has previously been reported (Orris & Whitehead, 2000; Hathaway, 1999). Furthermore, regarding the role of international organizations in food safety, a constructive collaboration of consumer organizations with other stakeholders in the food chain, as well as through a concerted and coordinated approach for communication with the public, is a key to regaining the trust of consumers in the food supply chain (Motarjemi & Mortimore, 2005).

It is noted that in response to increasing consumer concerns about food safety, regulators in the EU, the US and Japan have been raising the bar that food suppliers need to meet in order to be able to sell on their markets. This includes stricter norms on pesticides and veterinary drug residues and mycotoxins – some of which are powerful carcinogens – as well as on microbial contaminants. In addition, Hanak et al. (2002) emphasize that quality needs to be managed not only in the processing company but also along the whole supply chain, from the initial stages of raw material production to the final stages of food preparation for consumption.

In short, while the improved level of food safety associated with the implementation of HACCP and the leading role taken by the food industry are recognized, the application of HACCP as a public policy requires a definition of the role of government in the HACCP process. Recent moves by some importing countries to require application of HACCP principles by exporting countries to food produced for export may result in significant trade barriers for countries unable to meet these requirements. The mandatory requirement for HACCP use and any subsequent barriers or other constraints to trade for developing countries need to be considered and identified.

2.4.2 The implementation of HACCP in the world

One can generalize that the HACCP system in FS for prevention of hazards is now mandated for some or all of the food sectors in the EU, the US, Canada, New Zealand, and Australia (Unnevehr, 2002). In fact, the food safety concept may be differently interpreted in different nations as food preparation and food consumption habits differ. Therefore, the introduction of food safety management in general and HACCP in particular needs to be built on local skills and concepts. At the very least it should be built on mutual understanding of each partner’s perception, and participatory approaches. Mutual understanding, however, assumes certain minimal skills (farmers, inspectors, veterinary staff, etc.) and an understanding of the concepts of standards and risk assessment (Van Veen, 2005).

Focusing on seafood quality and safety, Cato (2000) reports that HACCP was recommended as the most effective way to monitor the safety of fish before
1985. The use of HACCP in the seafood industry has taken on a global perspective in the production of fish and fisheries products (Santos et al., 1998). They report the results of an FAO survey that categorized the status of countries and the seafood industries in those countries in terms of their adopting HACCP seafood procedures. Countries whose governments and seafood industries have adopted or decided to introduce seafood HACCP include Canada, Uruguay, Brazil, Chile, Ecuador, Australia, New Zealand, Thailand, Iceland, the US and, more recently, Argentina, Peru, Ireland, Cuba, Morocco, Norway, Sri Lanka, Vietnam and Bangladesh. A second group consists of countries whose governments have taken unilateral initiatives to introduce HACCP via regulations with limited success and through cooperation between the regulatory authorities and the seafood industry. These countries include Mexico, Venezuela, and many countries of the EU, for example Italy, Germany and France. In a third group of countries, the private sector is taking the lead in voluntarily trying to introduce HACCP based programs regarding seafood export production. These include Madagascar, Venezuela, Honduras, Tunisia, Myanmar, and Portugal. A final group consists of countries where governments have decided to apply HACCP but have not yet defined the process, including Japan, Russia and China. The remaining countries where the status of seafood HACCP is unclear include Pakistan, South Korea, Iran, Colombia, Panama, some East and Central European countries, and most African States.

Billy (2002) reveals that FS in the US is based on HACCP and SSOP. HACCP is the industry’s tool for meeting the relevant performance standards. Both FS objectives and corresponding performance standards are best accomplished through HACCP. FS in Malaysia combines the implementation of the HACCP along with GMP, hygiene and sanitation, and environment control (Merican, 2000). In Australia the food safety program is based mainly on HACCP principles. However, it was ultimately agreed that those food safety standards would not be applied to the entire food production chain as the primary food industry sector is specifically excluded. It was, however, recognized that the food safety standards could be applied to a primary food production activity if significant and unmanaged food safety hazards were identified in this sector (Martin et al., 2003).

In Canada, two food inspection programs have been developed to embody these internationally recognized principles of safe food processing – The Quality management Program (QMP) and the Food Safety Enhancement Program (FSEP). Under both QMP and FSEP initiatives, food manufacturers are responsible for the development, implementation and maintenance of HACCP food safety management systems to ensure compliance with health and safety regulations and trade agreements. These food safety management systems must include a hazard analysis, written procedures for control of hazards and written procedures for verifications of the system’s effectiveness (Gagnon et al., 2000).
Kvenberg et al. (2000) report the US experiences in dealing with HACCP for seafood plants from a regulatory perspective. They are (1) GMP, SSOP considerations as a prerequisite to HACCP implementation; (2) General HACCP principles; (3) verification methods of industry development, implementation, and maintenance of effective HACCP systems; (4) performance standards; (5) engagement in internal and outreach programs of education and training; and (6) sponsorship of research to improve HACCP systems functionally. Besides, measuring the effectiveness of a new food safety program such as HACCP is an important consideration if regulatory agencies are to develop information on the advantage of conducting an HACCP-based audit over conducting a sanitation based inspection. Both the food industry and the regulatory agency share the same goal of ensuring a safe food supply. However, there are HACCP implementation difficulties in some industry segments because the general principles of the HACCP are not fully understood. Despite these difficulties, however, numerous HACCP program successes have occurred. These include successful implementation of SSOP in 6000 meat and poultry plants and a significant reduction in the prevalence of salmonella in poultry plants where HACCP has been implemented.

According to Lee and Hathaway (1999), New Zealand and other countries (Canada, Uruguay, Brazil, Chile, Ecuador, Australia, Thailand, and Iceland) consider the implementation of HACCP systems to be an important component of safety for food in international trade. Given that the global experience regarding HACCP across all food sectors, especially in primary production, is relatively new, both importing and exporting countries have much to learn in assuring that the safety of food in international trade is underpinned by HACCP systems that are scientifically derived, risk-based and equitable.

However, Eves and Dervisi (2005) note that there is little doubt that HACCP is becoming more widely accepted throughout the UK food industry. Its successful implementation, however, requires an understanding of its principles and a commitment thereto by all levels of the workforce. HACCP per se does not make food safe; it is its correct application that can make a difference. In order for this to be achieved, the barriers to HACCP should be assessed and their impact evaluated. Until these barriers have been resolved, HACCP systems will not be able to reach their full potential. Barnes and Mitchell (2000) made similar observations.

Although there are many papers presented and discussed about experiences of HACCP implementation as above mentioned, successful experiences of Thai fisheries in the application of HACCP presented by Suwanrangsi (2002) are good references for Vietnam’s fisheries industry in general and for SFCs in particular due to the same conditions of HACCP implementation.
2.5 Food safety constraints and problems in developing countries

The international workshop on food safety management in developing countries, as reported by Orris, and Whitehead (2000), Hanake et al. (2002) and Van Veen (2005) emphasizes that prominent food scares and change in the international trading environment have brought food safety to the forefront of international agri-food policy concerns. Recent trends include an increased emphasis on food safety regulations in international trade, a tightening of standards, a reorientation of private sector quality control techniques toward preventive management, and a corresponding shift by regulatory agencies toward process-based standards including mandatory HACCP in the food supply chain. In fact, in order to meet FS requirements in international trade, the application and development of HACCP in developing countries still encounter constraints in terms of deficiencies in basic hygiene measures such as environmental controls, management of employee hygiene, investment in technology, equipment design, and management of cross contamination. These constraints are managerial as well as technological.

2.5.1 Technological constraints in HACCP implementation

Orris (1999) and the discussion of world experts on food safety (2002) indicate that many developing countries have difficulty overcoming the technical deficiencies and providing new technological investment. They frequently require technical assistance in order to fully understand and implement the sanitary measures. Besides, there are differences among food companies in terms of the level of technical expertise, along with the pressures and incentives for management to adopt the HACCP concept. The introduction of HACCP systems in developing countries has depended very much upon the level of technology. The larger companies usually have modern equipment and excellent technical support, but the smaller operations may have no technically trained staff and they may be using traditional equipment and methods to produce a large range of products (Jirathana, 1998). Besides this, Panisello et al. (2000) discuss that improving the microbiological quality of foods alone is insufficient, since food processing technologies cannot always guarantee the absence of pathogens. Foods can also easily become recontamination. Therefore, efforts must be made to adhere strictly to hygiene measures by following GHP, GMP and by stringently implementing HACCP along the whole food chain. Similar attitudes have been observed in the study of Legnani, et al. (2004).

These issues aside, food processing technologies are also applied to increase digestibility, enhance the edibility of food, intensify sensory quality, increase shelf life, improve nutritional quality, and/or render food safe. Food processing technologies implemented at either the household level (e.g., farms, collectors and wholesale buyers), or at the industrial level are designed to optimize all of these properties in the final product. All of the above objectives can rarely be
achieved using a single operation (Motarjemi, 2002). For instance, the application of the basic rules of food hygiene will help prevent contamination, growth and survival of pathogens in foods and will reduce the incidence of diarrhoea diseases.

2.5.2 Managerial problems of HACCP implementation

Managerial problems in developing countries in HACCP implementation also encompass the internal and external ones of food companies. A key point of external managerial problems is issues of HACCP inspection and audit. In contrast, activities regarding employee hygiene and training are main internal management problems. Eves and Dervisi (2005) mention the role of management in implementing and maintaining HACCP. In almost every food company, HACCP management has been implemented. Managers and most of the head chefs have been trained specially in HACCP because of a perception that HACCP would be too complicated for their employees. Thus, a major part of the monitoring has been performed by those who are qualified or trained (quality control staffs, managers) and the less hazardous jobs are performed by other employees. Managers at all levels have understood their role to be an important one because they recognized on the one hand that their attitudes towards the system affected the way their employees behaved. Which employees are trained and at which level and how their roles for FS are managed are, on the other hand, managerial problems. The more interest and excitement they show in their job and the more committed the managers are, the better the result obtained. A number of other authors (Panisello & Quantick, 2001; Mortlock et al., 1999; Easter et al., 1994) have also identified the same managerial problems in HACCP implementation and maintenance regarding management attitudes and commitment to employees.

In addition, a variety of problems in the application of HACCP have been reported by Panisello and Quantick (2001), Mortlock et al. (1999), Panisello et al. (1999), and Ward (2001). The most important problems reported were the level of knowledge shared by employees, various time constraints and additional documentation. Managers seemed to find it difficult to make their employees understand the importance of hazard analysis and why particular operations had to be monitored and controlled. To overcome this they ensured that adequate supervision was in place and that people who had problems with the system were identified and retrained. Time-related issues in correctly applying all monitoring procedures and controls were noticed, especially during busy times. Panisello and Quantick (2001) report similar issues. During busy times there was a tendency to forget personal hygiene and the completion of required documentation. An insufficient identification of hazards was also reported by management as a problem when the HACCP system was beginning to be introduced in food companies. Panisello et al. (1999) previously reports that inadequate hazard identification is a major drawback to the effective
implementation of HACCP. The problem seems to have arisen because of the lack of understanding of what hazards are and how they should be identified and incorporated into the system. This indicates the sort of background that a manager should have when implementing an HACCP system.

Moreover, the uncertain authority of employees who are responsible for taking corrective action is one of the problems that should be considered in developing countries. In principle, the top management must themselves commit to fully supporting the authority of those to whom they give responsibility for corrective action. However, sometimes top management can be governed more by economic factors than by the safety aspects of the company’s products. It is difficult to convince top management to fully accept the HACCP principles throughout the whole chain. In addition, there is a shortage of effective and experienced auditors. Auditing involves more than access to records of CCPs, assessment of HACCP manuals, sampling at CCPs and verification of records (Dillon & Griffith, 1996). Auditors should also inspect production lines and other facilities to ensure that any new hazard has been identified and taken into account; also their focus should be extended to food safety auditing (Peters, 1999; Taverniers et al., 2004; Leaper and Richardson 1999; and Orris, 1999).

2.5.3 Techno-managerial constraints of HACCP implementation in Vietnam

Like some developing countries, the HACCP implementation of Vietnam’s SFCs in general and in the MD in particular is facing constraints in terms of management and technological investment. There is a lack of strict quality management by the government, industry, support organizations, SFCs, and chain stakeholders from “water to table.” In addition, restrictions on quality knowledge, techniques, infrastructure, and technological and equipment investment throughout the chain are a big challenge for seafood quality and safety. Moreover, because the HACCP has not yet been introduced at the primary production level, the roles of the government (the Ministry of Fisheries, local government departments), SFCs and support organizations (VASEP and NAFIQAVED) throughout the chain are vital. Those are the reasons why food safety and quality by means of the techno-managerial approach, the combination of supply chain management and quality management, the role of the government, SFCs and other relevant organizations are crucial in order to provide a detailed understanding of their roles in solving research problems.
2.6 Techno-managerial approach for food safety and quality management

There are many approaches for implementing chain food safety quality control. One, for instance, is an integrated and science-based approach as presented by Sheridan et al. (1996). This approach is based on shared responsibility, the use of HACCP principles/practices and the introduction of leading technologies and detection methods within government and across the food industry. The process involves defining accountabilities more clearly across the entire food continuum and working with partners and stakeholders more closely. Other approaches, such as the FAO approach, as well as the integrated approach of Kailis et al. (2000), focus mainly on elements of general design and operation of hygienic premises, and equipment and training of personnel. However, the techno-managerial approach indicated by Luning, et al., (2002) and Poon & Lijanage (2003) ranks highly in solving research problems because there is an integration of managerial and technological sciences.

2.6.1 Techno-managerial approach

Luning, et al. (2002) and Poon & Lijanage (2003) mention that food quality management embraces the integrated use of technological disciplines as well as the integrated use of managerial sciences. The following figure describes three different approaches – the managerial, the technological and techno-managerial approach. They differ in their extent of integration of managerial and technological sciences.

- The managerial approach means that technological aspects are contemplated as facts: we can make everything we want to make. In fact, there are no technological restrictions.
- The technological approach means that management aspects are considered as boundary restrictions: we cannot make everything we want due to technological restrictions.
- The techno-managerial approach encompasses integration of both technological and managerial aspects. Quality problems are considered interactively from both a technological and managerial viewpoint. This approach is suitable for solving seafood quality problems in the MD because seafood supply chain problems in general are now faced with technological and managerial restrictions as well as technical and local infrastructure problems. Moreover, a good example of techno-managerial thinking is the HACCP system, wherein critical hazards are controlled by human control and monitoring systems, and consumers’ wishes are translated into technological requirements through an intensive and organized collaboration of different departments in the company.
In addition, Banati et al. (2002) emphasize in Food Safety and Quality that the ability to integrate technological and managerial knowledge is very important for food safety and quality design, control, improvement, and assurance. With a particular focus on food safety and quality the quality management skills needed are:

- ability to apply the techno-managerial approach in food production processes
- ability to develop and use models for (statistical) quality control
- ability to solve problems
- communication skills, with a focus on stakeholders
- ability to work in multidisciplinary teams

### 2.6.2 The food quality management model by means of a techno-managerial approach

Figure 2.2 shows how the techno-managerial approach resulted in the food quality management model (Luning et al., 2002).

The model includes:

- the organization in its environment, wherein
- management and technology interact, striving for
- product quality that meets or exceeds customer expectations
- wherein technology is perceived as a technological system, with complex interactions fulfilling different functions in order to meet product quality requirements, and
- wherein management is perceived as a management system with complex interactions fulfilling different functions in order to activate the technological system and give it the right direction, while ensuring that it meets customer expectations.

![Food quality management model (Luning, et al., 2002)](image)

**Figure 2.2** Food quality management model (Luning, et al., 2002)

Furthermore, the objective of quality control is to guarantee that quality requirements, such as product safety, reliability, service, etc., are realized by the quality system. On the other hand, quality control should provide confidence to customers and consumers that quality requirements are being met (ISO, 1998). A quality system is defined as the organizational structure, responsibilities,
processes, procedures and resources that facilitate the achievement of quality management (NNI, 1999). In the food industry several quality control systems (QAS) and norms have been developed but they differ in their quality focus (e.g., food safety, supply guarantee, total quality) and their approach (Hoogland et al., 1998; Waszink et al., 1995). With respect to approach, GMP and HACCP mainly focus on assurance by technological requirements, whereas ISO is more focused on management. Figure 2.3 illustrates how the common QAS are mapped by means of their technology and management focus.

Because GMP/GHP involves guidelines that are aimed at assuring minimum acceptable standards and conditions for processing and storage of products (buildings, processing technology, equipment, and utilities), it has a technological focus and is a basic condition for other systems like HACCP. An ISO-based quality system, on the other hand, consists of all activities and handling being established in a procedural way, which must be followed by ensuring clear assignment of responsibilities and authority. In actual practice, procedures on all relevant topics had to be established, then carried out, and controlled. This brings a management focus into the forefront. The role of HACCP is a necessary step in transforming a technological focus into a management focus and is also a basic condition for ISO/TQM application and success.

![Technological focus

GMP

HACCP

ISO

TQM

Management focus](Figure 2.3) Common QAS schematically mapped according to their technological and management focus
This point of view towards quality control systems is also discussed by Nicolaides (2002), where linkages are established between what are typically viewed as successive stages of the preventive approach to quality control (GMP, HACCP and TQM) in individual supply chains. Similarly, Jouve (1998), Huss and Ryder (2003) emphasized that GMP and SSOP are generic requirements. The HACCP is a specific requirement for food safety management, while ISO includes all quality elements that need to be assured and managed and TQM is a long-term managerial strategy. Lackova (2001) also mentions that the HACCP system is a more narrowly applied system for ensuring the quality of products and one which is compatible with other systems such as quality systems following ISO 9000 and TQM.

Furthermore, food companies aiming to achieve a certificate for their system of quality according to ISO 9000 are bound to work out an HACCP system for respective products, processes and phases of production, which simultaneously observes a certain progression of steps determining decisive points in this system. Therefore, food companies have to start work on building up a quality system through implementing just such an HACCP system for use as a specialized instrument and as a specialized part of the quality system. On the other hand, construction of an HACCP system does not yet mean the fulfilment of all requirements of ISO 9000. The common points of both systems lie in following the elementary points of ISO 9001: a quality control system, requirements for purchased products, identified ability and the ability to follow the product, operational management, manipulation, storage, packaging, protection and supply, internal audits, operational management of quality recording, training and preparation of workers, statistical methods, etc.

The application of ISO 9000 international norms and the HACCP system are individual steps toward achieving minimum European quality standards and thus the ability to compete on the food product market (Lackova, 2001). Although ISO 9000 and HACCP both focus on preventing not detecting or correcting problems, an important difference is that HACCP focuses on the product and ISO 9000 on the system. The development of the HACCP plan identifies critical control points and procedures or activities identified in order to adequately control them so as to ensure safe production of a food product. The ISO 9000 quality management system provides the structure and foundation for the maintenance of the quality system, while, as such, certification for conformity to an ISO 9000 standard will not actually certify the product. What it does certify is that the approved company has a quality system that meets the scope of the stated standard (Newslow, 2003).

Cato (2000) emphasizes that HACCP programs in both developed and developing countries often include quality standards as well as safety standards in their program design. However, in European countries HACCP is more broadly defined as part of an overall ISO 9000 system because of the better
conditions of management, capital, quality knowledge and technological investment. Therefore, seafood companies can be certified to meet various ISO 9000 standards. SFCs in Vietnam follow the EU approach. It means that they have applied HACCP as part of an overall ISO system and as a prerequisite condition to achieve ISO certification.

2.6.3 Food supply chain management

Food supply chain management covers the management of the food supply system from the farm, to food manufacturing, to retail and wholesale markets, and to consumer issues (Bourlakis & Weightman, 2004; Eastham, et al. 2001). Relevant issues to the management of food chain include (1) The food supply chain management environment, (2) The food consumer, (3) Public conceptions of risk and product safety in the food supply chain, (4) Procurement and supply chain management, (5) Food Manufacturing, (6) Food retail and wholesale, (7) Food strategic alliances and networks, (8) The impact of information, (9) Technology and electronic commerce in the food supply chain management, and (10) The future of food supply chain management (Bourlakis & Weightman, 2004). Regarding food chain safety and quality, Luning et al., (2002) also mention that food quality management must attain quality and safety standards stemming from customers’ requirements and expectations. These requirements and expectations are transformed into the company’s performance quality objectives. To implement these objectives, partnership relationships between food companies and their chain actors, and even with loyal customers are crucial. So far, SFCs in the MD do not satisfy the managerial and technological conditions and lack the financial possibilities to implement the ten topics of food chain management. For instance, internal competition among SFCs still exists, chain actors’ quality knowledge is low, chain information is insufficient and, especially, relationships between SFCs and between SFCs and their chain stakeholders are still weak.

2.7 Summary

The literature reviewed has provided grounds for diagnosing a supply chain quality management framework and a quality improvement process. The theories and concepts with reference to the HACCP role in the food supply chain safety and food quality management by means of a techno-managerial approach are described. More especially, HACCP implementation and the experiences of HACCP application in the world’s food chains are mentioned in detail. This Chapter has also shown the important role of government, industry and other relevant organizations in the food chain safety as support organizations for successful implementation of an HACCP program.