Application of Knowledge Management in HACCP performance: A Systematic Review

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Abstract

Hazard Analysis and Critical Control Points (HACCP) is a preventive and protective system that assures the safe manufacturing of food products. It helps in preventing, reducing, or eliminating food hazards. These food safety hazards could be physical, chemical or biological. HACCP performance is measured against the development of budget, staffing decisions, pricing, costing, and packaging in the food manufacturing industry. Therefore, this paper reviews the management of various knowledge areas in the HACCP performance method. The literature will be collected using research databases like EBSCOhost Online Research Databases, FSTA (Food Science and Technology Abstracts), Nutrition and Food Sciences database, Food & Beverage Industry Databases, Databases for Food Science and Human Nutrition, The EFSA Comprehensive European Consumption Database, Hospitality & Tourism Complete (EBSCO), IBIDS, International Bibliographic Information on Dietary Supplements, Annual Reviews Nutrition, ABI/INFORM Collection (ProQuest), etc. The primary areas of knowledge management in HACCP areHACCP methods; performance measures which include both internal and external measures; verification; relationship among HACCP, ISO9000; and regulation of this relationship.Nevertheless, the effective implementation of HACCP in the organizations has several challenges like lack of knowledge about cost of HACCP, management support in terms of knowledge dissemination, people as resource for successful implementation. This paper would systematically review the primary

areas of knowledge management in HACCP and the challenges and barriers in effective implementation of HACCP in the food industry. The research gap thus recognized from the review is expected to provide directions for future research on knowledge management in HACCP performance methods.

Keywords: HACCP, Hazard Analysis Critical Control Program, Knowledge management, Diary industry, Food industry.

1. Introduction

Foodborne diseases are a serious threat to the mankind and the numbers of victims across the globe are on the rise, despite the substantial advances in the food handling technology. Millions of people are affected by these diseases in developing countries every year, and the people in developed countries are also not immune to it (FAO and WHO, 2006). Awareness about the health risk caused by the food borne diseases has increased among the consumers, and consumer voice for the proper food safety measures has become louder. Such unified voices have awakened the food safety authorities and force them to implement proper food safety measures. Among the various food and safety measures which are in use, Hazard Analysis Critical Control Program (HACCP) stands out as the most effective and most acclaimed method, which has been adopted by various both developed and developing countries across the world. Initially, HACCP was developed by US Army Natik laboratories and the National Aeronautics and Space Administration for the purpose of ensuring the safety of food used in the space program in 1960s (Soliman, 2000). Later, it was recognized as an effective alternative to conventional end-point-testing by the World Health Organization (WHO) and the United States Food and Agriculture Organization (FAO) among others, and recommended for use in commercial food production. HACCP covers the

biological, chemical, and physical production process and provides a framework for establishments to conduct scientific process controls that can be validated as effective in eliminating, preventing, or reducing the food safety hazards to an acceptable level that are reasonably likely to occur in an official establishment's particular production process. HACCP follows a seven point working principle that includes Conduct a Hazard Analysis, Determine Critical Control Points, Establish Critical Limits, Establish Monitoring Procedures, Establish Corrective Actions, Establish Record Keeping and Documentation Procedures and Establish Verification and the proper implementation needs the effective functioning in each step.

Recently HACCP has become popular and has been used in different areas of the food manufacturing industry to assure the safety of the food. The implementation of HACCP in meat industry was studied by Tompkin (1994) and concluded that HACCP is capable of eliminating the food hygienic problems to a great extent as it has a dynamic implementation plan. The application of HACCP has also been extended for implementation and evaluation of systems for the reuse of water in the food industry (Casani & Knøchel, 2001). HACCP has been used in several industries and one of the prominent industries where the demand and usage of HACCP is at high is the dairy industry. Milk and milk products are highly prone to contamination and can be agents of various food borne diseases. Unhealthy practices in dairy farm units at milk reception centres, processing lines and post-processing handling are linked to the potential health risk to consumers, due to the presence of pathogens and environmental contaminants in the milk. This necessities the implementation of HACCP, the program which is appreciated across the globe as the one of the best food safety program available to deal with food contaminants. According to Noorduizen (2005), HACCP is the best quality control program for dairy farms, because it is highly farm-specific, easy to link up with operational management, relatively low in cost, both product and process oriented, and not requiring

much labor. HACCP has been implemented in diary industries of various countries across the globe, including the US, UK, Australia, Lituania, South Africa, Brazil and Turkey. On the other hand, India, although the largest producer of milk and milk products, is still lagging behind in the study and proper implementation of HACCP. Out of the few studies, the study of Yadav & Boroude (2016) highlighted the challenges faced by the dairy industry in implementing HACCP. The major challenges in implementation include the need of awareness and responsiveness of HACCP, lack of apparent reimbursement, lack of industrial personnel training, lack of management commitment, unevenness of production lines and individuality of each product, lack of government support and lack of technical expertise. However, many of these challenges can be dealt with the application of knowledge management, a process which includes the efficient handling of resources and information within an organization. Studies by Davenport and Prusak, (1998), Nonaka and Takeuchi, (1995) throw some insight into this area.

This motivates the current study which has the objectives that include to conduct the systemic review of the studies regarding the performance of HACCP in food industry with specifically focused on dairy industry, to analyse the studies in order to understand the challenges in the path of implementation and effective performance of HACCP in diary industry in general and in India particular, to conduct the extensive review of the studies to analyse how the proper application of knowledge management helps to overcome these challenges.

2. Review

This section conducts the extensive review of the studies related to implementation and performance of HACCP in the food industry with specific focus on dairy industry. The reviews of the studies regarding the various challenges for the successful implementation and effective working is also conducted. Further, the studies regarding the application of knowledge management in HACCP in diary industryand its impacts are being reviewed.

2.1. HACCP in Food and Dairy Industry

Mayes (1992) studied about the factors influencing the HACCP implementation in the food industry. This study stated that the HACCP implementation is team process and in most cases the individual who are part of the implementation team need not have the entire knowledge regarding practical, technical, theoretical and managerial aspects of implementation. Rather the selected HACCP team must be trained to achieve the necessary range of expertise to identify all hazards, CCPs and critical limits associated with the product and/or process under consideration.

Collar (1997) studied the risks and implications of food and waterborne pathogens that were uppermost among public health concerns, and reported that the agriculture sector was under pressure for immediate adoption of on-farm controls. He observed that the FDA was looking into HACCP as a basis for revising the US Food Safety Assurance Program as HACCP is a scientific, step-wise approach to ensure food safety. Additionally, he reported that the implementation of HACCP allows the government to oversee better due to its requirements for SOPs and systems for keeping records, assign responsibility for ensuring food safety on the manufacturer or distributor, and enable US companies to compete with more effectiveness in the world market. The HACCP-based program would enable a government investigator to locate and analyse both present and past conditions critical to enabling food safety of the food produced.

Boccas et al. (2000) conducted a training program in the Lituaniandiary industry regarding the implementation of HACCP. The program was organized in two main two main phases with different and complementary training approaches. After the four days of intensive training the project team conducted a visit to the each diary plant which was selected by the Lituanian government. On-site training regarding the implementation of HACCP is provided

to the factory staffs. The result shows that how effective this on-site training sessions in providing the in-depth understanding of HACCP method.

Ropkins and Beck (2000) reviewed the methodologies of HACCP used to control food safety in the US, UK, Netherlands, Germany, Canada, Australia, and New Zealand. They concluded that there is now extensive adoption of HACCP in both government and food organizations in these countries and that HACCP has been generally accepted as an important system for the regularization of food quality control and assurance methods for trading across countries. Hence, HACCP would emerge as an increasingly necessary aspect of food safety activities and legislation in the future. Therefore, it is critical that (i) effective guidelines for HACCP establishment are set up by governments, and (ii) these are effectively followed by the companies to ensure maximum food safety.

Casani and Knøchel (2002) studied the reuse of water in the food industry, which is important due to the rising cost of water and its discharge. The frequent reuse has a potential hazard for microbiological infection of food and the workplace. A HACCP-based generic model was described for the establishment and study of mechanisms for the reuse of water in these industries, which covered data on food and waterborne pathogens and their response to different water treatment methods. It was seen that planning, establishment, and control required expertise in food and water microbiology, processes, control options, and hygienic design. Also, information from case studies was found to be inadequate.

McAloon (2003) invites our attention to one of the important factor that influences the successful implementation of the HACCP, i.e., the cost of the HACCP functioning. According to the study, the total relative costs of HACCP involve the sum of all resources made available at the different stages with the technological level of the plant and the non-

compliance with prerequisite programs contribute to greater costs in the implementation of the system.

Maldonado et al. (2005) examined the levels of HACCP implementation, the cost of HACCP implementation and the benefits of implementation in Mexican meat industry. The survey was conducted among 160 Federal Inspection type enterprises with a response rate of 58%. Among the respondents, only 18% of the enterprises have completely adopted HACCP while 20% reported that they were not interested in implementing HACCP. According to the results of the study, one of the major problem that pulls the enterprises back is the difficulties in the staff training. Further, it is the problem regarding the cost which mainly comes from the investment in new equipment and microbiological tests of products and operational cost.

Sperber (2005) challenged the implementation practices of HACCP in food safety. The study argued that HACCP was established to support quality assurance activities for food safety to include hazards that take place infrequently. But with the HACCP system gaining worldwide acceptance, an incorrect perception was created that it could be used effectively in all stages of the food supply chain, from the farm to the consumer. This is due to insufficient precise critical control points that could check identified hazards, thereby restricting the effectiveness of HACCP in all the stages. The study also pointed out that food safety measures need to be enforced at each stage in the form of prerequisite programs rather than implementing in HACCP critical control points. The study further suggested that the approach of 'Farm to Table Food Safety' needs to replace a 'Farm to Table HACCP' approach.

Buchweitz and Salay (2006) in their study carried out in food services in the region of Campinas, Brazil, pointed out the various challenges and problems that create the hindrance for the implementation and functioning of HACCP in the food industry. The results of the study reveal that the lack of awareness and information about the implementation and functioning and the economic factors are the main reasons for not adopting HACCP.

Jevšnik, Hlebec and Raspor (2008) studied about the impact and challenges of implementation of HACCP in the food service and retail industry. The study results revealed that the various challenges that limit the implementation arises out of lack of knowledge, training, high staff turnover, the large variety of products, change in potential demand, variability in workloads, and the large numbers of part-time workers.

Karaman et al. (2012) in a study tried to determine the difficulties and benefits of HACCP and food safety programs used by the dairy industry in Aydin, Turkey. By conducting interviews and using questionnaires, the framework of the food safety management systems (FSMS) in Adyin's dairy plants was identified. The questionnaires gathered information about the usage of FSS, management's views on inspection methods, and their hopes from the government and local legal authorities for FSS. Twenty-eight licensed dairy units running in Aydın for over 10 years, which produced butter, fermented milk products, and white cheese, were studied. It was seen that the implementation of an efficient FSMS improved legal problems (85.7%) and increased customer trust (64.3%). This had a positive correlation to the ages of the managers in dairy plants in the area ($p< 0.05$ and $p< 0.01$). Yet, poor knowledge of HACCP was identified as one of the main hurdles in its use. About half the managers (46.5%) claimed ignorance of HACCP, while 35.8% informed that it was very expensive to implement. The primary hurdles with the prerequisite program (PRP) deployment in these dairy plants were found to stem from insufficiency in physical conditions (35.7%) and cost issues (46.4%). Ignorance of HACCP and other food safety programs were key hurdles to implementation. Providing frequent training, consultation and financial support by the government is essential.

Anandappa (2013) studied the relationship between the degree of involvement in such activities and the retention of information over time. Training improves HACCP accuracy of

the knowledge. Involvement in HACCP immediately after completion of training helps to retain knowledge, and refresher training within three years also is beneficial.

Yadav, Mahna, and Rekhi (2015) also reviewed food safety research in India. It is seen that there is a lack of dependable data on critical issues like HACCP, risk assessment, knowledge, attitudes, beliefs and practices. There have been few studies to assess the food hygiene and safety management in the catering sector in India. Poor food hygiene and safety knowledge poses a major threat of serious health hazards. A more earnest outlook to risk analysis, early and rapid alert mechanisms are expected in the coming days as the exporters are required to adhere to stringent export norms and standards. FSSA has been launched by the government

Jan, Yadav, and Borude (2016) proposed to set up a HACCP plan for a dairy unit in Pulwama Jammu & Kashmir to minimize the hazards and ensure safety in milk and cheese produced, to assess the level of conformance to food safety, and to study the actual HACCP implementation. HACCP has been reported as an effective and sensible method for food safety at all stages from production to consumption. It is considered to be an international standard to address chemical, physical, and biological hazards through prevention and anticipatory action, rather than testing and inspecting the end-product. The study was carried out on actual conditions in the dairy unit using the seven basics of HACCP. Many standard models of HACCP were applied using a qualitative methodology to minimize the hazards and to ensure safe dairy products. First, the sequence for implementing the HACCP program was outlined. Next, the step-wise hazard analyses of milk & cheese were carried out, followed by HACCP plans for both items. CCPs were monitored in the production process, making use of the decision tree, the most important of them being working of UV light, pasteurization temperature, metal detector, and cold storage temperature. The prerequisite program was followed to tackle hazards in order to reduce the CCPs before the production to make the HACCP plan simpler.

Yadav, Mahna, and Rekhi (2016) studied the difficulties in implementing a HACCP system in a country such as India and the challenges therein. The results reveal that multiple barriers, such as knowledge, resources, government support, meager funds and illiteracy which acts as the barrier for the successful functioning of HACCP in Indian food industry.

2.2. HACCP and Knowledge Management

This section reviews the studies which examined the the impact of the application of knowledge management in overcoming the challenges that creates the blockade on the successful functioning of HACCP in food and dairy industry.

A study by Nonaka and Takeuchi, (1995) stated that the proper communication and management of the explicit knowledge is one of the best tools to overcome the challenges Associated with the HACCP performance.

Davenport and Pruzak (1998) studied about the components of knowledge management and its impact on the performance of HACCP in the dairies of NewSouth Wales. The study indicates six primary areas of knowledge that is important in the performance of HACCP. This includes performance measures, HACCP method, verification, internal performance measures, external performance measures and relationships among ISO9000, HACCPand the NSW dairy industry and its regulation. The study stated that proper management of this knowledge will enhance the HACCP performance and in turn will give the competitive advantage.

Soliman (2000) studied about the application of knowledge management for hazard analysis in Australian dairy industry. The study reveals that the application of knowledge management tools in the dairy industry enables monitoring of all dairy activities which will ensure that consistent food safety is assured. Study also pointed out that the cost of functioning of HACCP can be reduced by the implementation of digital knowledge management tools such

as knowledge based system which is a software application that seeks to replicate the problem-solving and decision making approaches of the HACCP experts. This soft ware is also is best suited for procedure-intensive tasks which involve the processing of large volumesof HACCP data manipulates facts, relationships between those facts, and heuristics within a narrow and bounded HACCP area.

Okello (2005) examined the complication and challenges in the face of proper implementation of HACCP and the measures taken to overcome the challenges. The findings of the study the pointing toward the importance of the knowledge management. The study states that the standard implementation requires the understanding of complex requirements and regular updating of this information. However, conclusive results of the study suggest higher education and experience as the measures to combat with problem.

Study by Will (2010) examined the various factors that influence implementation of HACCP in the food industry. This study invites the attention of the readers to a different dimension of knowledge management, which is done through the connectivity between the food producers and the possible information exchange as a result of this connectivity. According to this study this information exchange will increase the opportunities for proper implementation.

Handschuch, Wollini and Neto (2012) conducted a study aimed to evaluate the current state of implementation of HACCP in the small scale honey production industry in Brazil. They also examined the various hindrances that stand in the way of proper implementation. The study conducted an empirical analysis based on original survey data collected from a random sample of 115 households involved in apiculture in the northeast of Brazil. As a part of the data collection beekeepers were asked about their knowledge of HACCP requirements and the implementation of these requirements. Then, using the principal component analysis, study creates knowledge and implementation indices and compares these indices to relevant household characteristics and honey production conditions. The result revealed that

knowledge of requirements and the implementation are closely linked to households connectedness along the value chain. The study suggests the policy maker's intervention in the direction of fostering the cooperation and information exchange among the producers and also improving their connectedness to input and output markets.

3. Methodology

The study adopted a systematic review approach to ensure reliable, efficient, and accurate assessment of the relevant literature and to consolidate ample data extracted from a wide range of studies to a manageable compilation. The study uses the data bases such as EBSCOhost Online Research Databases, FSTA (Food Science and Technology Abstracts), Nutrition and Food Sciences database, Food & Beverage Industry Databases, Databases for Food Science and Human Nutrition, The EFSA Comprehensive European Consumption Database, Hospitality & Tourism Complete (EBSCO), IBIDS, International Bibliographic Information on Dietary Supplements, Annual Reviews (Annual Review of Nutrition), ABI/INFORM Collection (ProQuest), etc. to collect the research journals and studies journals regarding the HACCP and knowledge management. The study explored as much as 100 journals and research studies related to the corresponding topics with in the period of 1971 to 2017 using these databases for the purpose of review. These extensive search is conducted by using the key words such as 'HACCP', 'Food safety measurements', Diary industry' and 'Knowledge management'. From these papers the study filtered 20 papers for the in-depth analysis.

4. Findings

From the in-depth analysis of the selected papers, the study has drawn the following findings. The studies related to the implementation and performance of HACCP in food and dairy industry analyses the necessity of the implementation of the HACCP in the respective

industry and the result showed that almost all studies except the one by Sperber (2005) favours the ongoing practices of HACCP implementation. Meanwhile the studies by Sperber (2005) pointed some reservations on the practices and suggest the alternatives.

Along with favouring the implementation of HACCP the majority of the studies point out the shortcomings in the implementation and the various reasons for these shortcomings. Some of these reasons include lack of knowledge, high cost, lack of proper training, lack of government support, the lack of availability of resources, etc. Most of the, lack knowledge about the functioning of HACCP and its benefits, study points out lack of proper training for the labourers and staffs and high cost as the reasons that put hindrance on proper implementation and functioning of HACCP in the food industry.

Most of the studies available are conducted on general food industry. The number of studies which focuses on dairy industry are comparatively less. However, these available studies regarding the HACCP implementation and performance on dairy industry reveal the problems which are similar to that revealed by the studies conducted on general food industry.

Most of the studies are conducted on developing countries and hence the problems and challenges revealed by thesestudies can be taken as common to the developing nations. This assessment may help to find out some common solutions to tackle this problem.

The analysis of the studies regarding the application of the knowledge management in HACCP functioning does not give the conclusive results mainly because of the lack of availability of comprehensive studies. Most of the studies are in the nature of general studies and the specific results are lacking. Even though the study by (Soliman, 2000) in dairy industry and favours the application of knowledge management to tackle the various problems, the lack of empirical proof and further studies leaves it as a standalone case.

5. Conclusion

The study conducted an extensive and systematic review of the studies aimed to understand the challenges that cause the road block to the successful functioning of HACCP in food and dairy industry and also to assess to what extent the application of knowledge management will help to solve the problems and challenges. In the first section of review reveals the analysis of the various studies regarding the performance of HACCP in food and dairy industry. This section reveals some of the major challenges that needed to be tackled for the successful functioning of HACCP. This is followed by the review of the studies related to the impact of knowledge management in solving the problems mentioned in the previous section. In the following section the findings of these reviews are listed. These Findings shows the lack of comprehensive studies that assesses the performance of HACCP in the dairy industry in general and in India in particular. The findings also reveal that the number of studies that describes about the application of knowledge management and its impact on HACCP performance in dairy industry is very nominal and in general also the results of the studies are not enough to lead to a solid conclusion. This opens the door for the future studies that need to assess the performance of the HACCP in the dairy industry and the challenges that puts the roadblock for the proper functioning of HACCP and also to assess the impact of the application of knowledge management in solving these problems.

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