DEVELOPMENT AND IMPLEMENTATION OF A

METHODOLOGY TO PROMOTE BEST PRACTICE

SHARING IN FOOD PROCESSING INDUSTRY


By

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Abstract:
        Safety and quality of foods have been a growing global concern not only because of the continuing importance of public health but also the significant financial impact on the industry due to food safety and quality issues. Third-party audits, regulatory inspections, and customer audits encourage food safety representatives in food processing sector to meet regulatory and customer requirements to ensure safety and quality of food products whereas internal audits help for self-assessment of food safety systems. Although these aspects have been standard practices in the food industry, there is a need for tools to empower the food sector in diagnosing and improving their FSMS by promoting best practice sharing. With the intention of improving knowledge and awareness of food safety and quality practices, enhancing the knowledge and understanding continuous improvement programs with regard to food safety and quality, Oklahoma Audit Alliance (OAA) was formed. The underlying agenda of the audit alliance was to promote best practice sharing within the food industry in the state of Oklahoma. OAA consists of participants from food companies, students, and other food safety professional from Oklahoma. Appropriate training was provided to the audit alliance members along with the necessary tools to participation organizations and conduct food safety, product quality and continuous improvement focused audits. Kirkpatrick evaluation method was used to study the effectiveness of the program by measuring the increase in awareness, knowledge of food safety and quality as well as understanding continuous improvement programs. Mann-Whitney-Wilcoxon one-sided test was used to test the hypothesis. At $P<0.05$, it was observed that there was a significant increase in knowledge (P-value =0.024), awareness (P-value =0.043), and understanding continuous improvement aspects of food safety and quality (P value =0.00003) by participating in OAA program. This justifies that a knowledge transfer has indeed occurred by making food safety professionals audit different companies and thus promoting best practice sharing.

TABLE OF CONTENTS

# ACRONYMS AND DEFINITIONS

RC - British Retail Consortium

CAC/Codex - Codex Alimentarius Commission

CDC - Centers for Disease Control and Prevention

FAPC –Robert M. Kerr Food and Agricultural Products Center, at Oklahoma State University

FDA - Food and Drug Administration

FMI - Food Marketing Institute

FSIS - Food Safety and Inspection Service (part of USDA)

FSMA – Food Safety Modernization Act

FSMS – Food Safety Management Systems

FSQ – Food Safety and Quality

FSQMS – Food Safety and Quality Management Systems

FSSC – Food Safety Systems Certification

GAP - Good Agricultural Practices

GFSI – Global Food Safety Initiative

Global GAP – Global Good Agricultural Practices

GMP - Good Manufacturing Practices

HACCP - Hazard Analysis and Critical Control Points

ISO - International Organization for Standardization

MBNQA – Malcolm Baldrige National Quality Award

MBPEC - Malcolm Baldrige Performance Excellence Criteria

OAA – Oklahoma Audit Alliance

OFI – Opportunity for Improvement.

OQA – Oklahoma Quality Award

PRIMUS GAP – Primus Good Agricultural Practices

RCA – Root cause analysis

RTE - Ready-to-eat

SOP – Standard operating procedures

SSOP – Sanitary standard operating procedures

SQF - Safe Quality Food

USDA – United States Department of Agriculture

**Definitions:**

Food Safety:

It is the science that refers to the conditions and practices that preserve the quality of food to prevent contamination and foodborne illnesses.

Foodborne illness:

A disease that is carried by or transmitted to people through food.

Foodborne illness outbreak: "The occurrence of two or more cases of a similar illness resulting from the ingestion of a common food" (Olsen et al, 2000).

Food Recall:

A food recall occurs when there is a reasonable belief that a food may cause consumers to become sickness or even death. A food manufacturer or distributor initiates the recall to take foods off the market.

Food safety culture:

"The aggregation of the prevailing, relatively constant, learned, shared attitudes, values, and beliefs contributing to the hygiene behaviors used within a particular food handling environment" (Griffith et al, 2010).

Organizational culture:

"A pattern of basic assumptions- invented, discovered, or developed by a given group as it learns to cope with the problems of external adaptation and internal integration - but

that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (Schein, 1985).

Continuous Improvement:

It is defined as the ongoing improvement of products, services or processes through incremental and breakthrough improvements.

Hazard Analysis and Critical Control Point (HACCP):

"A systematic approach to food safety management based on recognized principles which aim to identify the hazards that are likely to occur at any stage in the food supply chain and put into place controls that will prevent them from happening" (Mortimore & Wallace, 2001).

Third-party certification:

Third-party certification means that an independent organization has reviewed the manufacturing process of a product and has independently determined that the final product complies with specific standards for safety, quality or performance.

Global Food Safety Initiative:

The Global Food Safety Initiative (GFSI) is an industry-driven initiative providing thought leadership and guidance on food safety management systems necessary for safety along the supply chain.

Internal auditing:

An internal audit is any audit completed by or on behalf of the company, rather than conducted by a second or third-party. For example, a company with a commercial interest e.g. a supplier audit, or an independent organization such as a Certification Body.

# LIST OF TABLES

LIST OF FIGURES

CHAPTER I


INTRODUCTION


**Rationale for the Study:**

Safety and quality of foods is a growing global concern not only because of the

continuing importance of public health but also the significant financial impact on the

industry due to food safety and quality issues.  Since food safety has become a quality

characteristic, food producers consequently are involved in communicating and enacting

food safety policies and practices. There are a number of issues that are influencing the

evolution of food safety regulations. As one of the measurements of the performance of

the quality management system, food producers are required to monitor customer

perception as to whether the organization has fulfilled customer requirements with regard

to food safety and quality.

The current food safety management systems (FSMS) in the food industry are

uniquely organized by food businesses and are inspected or audited by external auditing

bodies, regulatory inspections and/or third-party audits. All audits or inspections include

a complete report that discusses observations that may require corrective actions and

improvements that are to be made in order to comply with set requirements from external

parties (Luning et al., 2009).This third-party auditing has been a very effective approach

to have a strong food safety systems with excellent policies and procedures as most of the

audits demand mandatory maintenance of food safety policies, procedures and records. However, there is a need for tools to empower the food business operators in diagnosing and improving their FSMS. This is especially applicable to small and medium enterprises (SMEs),as they do not always have the necessary skills, experience, and resources such as finances, staff capabilities, knowledge about current and upcoming regulatory requirements (FSMA) and upcoming changes (Karipidis, Athanassiadis, Aggelopoulos, & Giompliakis, 2009; Jacxsens et al., 2011). Identification of tools required to share the knowledge between the business operators is necessary, and could help the small and medium scale food businesses to reassess their food safety and quality management systems.

A systematic method should be applied to the evaluation of the food safety performance of the FSMS, combined with a check on the approach of the company and the level at which core control and assurance activities are executed. The diagnostic tools, FSMS-diagnostic instruments, and microbial assessment can contribute to the measurement of food safety performance and help gain insight on the actual FSMS and the risk level of the existing measurement approach. Selection tools like the "quality assurance grid" and "microbial assessment scheme selection" (Jacxsens et al., 2011) and improvement tools (i.e. roadmaps for improvement, protocol for validation and verification), and finally, the FSMS support application can help to further elaborate improvements needed to increase the food safety commitment level and results. Use of these tools should empower the FSMS and lead to safer food products (Jacxsens et al., 2011).

Based on the observation and feedback from the food processors, one of the most critical needs of the American food industries is strengthening and support of the food safety and food defense programs. Globalization of the food industry has not just affected very

large American food processors, but almost every single food processor. The federal and state regulatory agencies have mandated standardized food safety and security regulations and policies that cut across all food processing sectors. The requirement to meet high levels of food safety and defense forces food processors to undergo rigorous third-party auditing for standardized food safety and defense programs. These include federal programs such as HACCP, and private sector retailer and customer driven global food safety initiative (GFSI) programs such as: BRC; SQF; ISO; GMP; and, FSSC 22000 systems. In the process of elevating the standards of FSMS systems, identification, development and implementation of a methodology is needed to share the knowledge between business entities. Knowledge sharing could significantly help the small and medium-scale food businesses to compare, reassess and improve their food safety and quality management systems.

**Objectives:**

The main purpose of the project is to develop, promote and implement an Oklahoma Audit Alliance (OAA).The OAA is an alliance of food safety and quality employees from multiple food processing companies within the state of Oklahoma. The objectives of the project are:

1. Develop the OAA program in the State of Oklahoma.

2. Promote the concept of best practices sharing among Oklahoma food processors.

3. Develop audit criteria and adopt GFSI schemes to address critical areas of business relevant to food safety, product quality, and continuous improvement.

4. Observe and document successful strategies and continuous improvement methods implemented by the participating organizations.

5. Assess existing Food Safety and Quality Systems (FSQS).

6. Analyze the effectiveness of the Oklahoma Audit Alliance methodology on the food industry (survey analysis).

**Hypothesis:**

Hypothesis 1:

Null hypothesis ($H_o$): There is no increase in awareness about food safety and product quality in OAA program participants.

Alternate hypothesis ($H_o$): There is an increase in awareness about food safety and product quality in OAA program participants.

Hypothesis 2:

Null hypothesis ($H_o$): There is no increase in knowledge and understanding about food safety and product quality in OAA program participants.

Alternate hypothesis ($H_o$): There is an increase in knowledge and understanding about food safety and product quality in OAA program participants.

Hypothesis 3:

Null Hypothesis ($H_o$): There is no increase in knowledge and understanding about continuous improvement on food safety of the OAA program participants.

Alternate hypothesis (H$_o$): There is an increase in knowledge and understanding about continuous improvement on food safety of the OAA program participants.

**Limitations:**

The following limitations were expected prior to undertaking the study

- It was not guaranteed that the OAA program would make food safer for the community.
- This study attempted to measure the effectiveness of a training model developed to promote best practice sharing. It does not involve any kind of specific training focused on food safety, product quality and continuous improvement strategies with respect to food processing.
- Major issues could arise with regard to confidentiality and code of conduct of the participants and participating companies. Some of the issues might include, willfully retaining documents after the audit process, and, retaining recipe and/or process information from the auditee.
- Participants may not be able give a complete review of the FSQS systems of the organization that is being audited.
- Techniques used to evaluate the effectiveness of the OAA program are based on satisfactory survey analysis and do not focus on financial advantages gained by organizations participating in the program.
- The number of participating companies might be small (n<10) as this is a new program. The sample size could affect the reliability of results.

**Dissertation arrangement:**

This dissertation document is comprised of five chapters, written under the American Psychological Association (APA) citation and format style. Chapter 2 and 3 present the Literature Review and Materials and Research Methodology, respectively. Chapter 4 includes results and conclusions. A complete list of references for this dissertation are provided in Chapter 5.Appendix F and G provides the content for two-journal articles that are to be prepared for submission to the Journal of Food Control. The writing and referencing style of Appendix F corresponds to the requirements of the journal. A list of references are provided at the end of Appendices F and G, which includes the references for the information sources for the content used in F and G respectively. Please note that information in Appendices F and G may be similar to the material presented in Chapters 1, 2, 3 and 4 as the journal article content was taken from these chapters.

CHAPTER II

REVIEW OF LITERATURE

**Food Safety**

Food safety is neither simple nor very complex as it sounds. It is the science that

deals with making food safe to consume by preventing physical, chemical and biological

hazards from entering in the food. Of the three types of hazards, food borne pathogens

has been a significant aspect of food safety. Control of Growth of food borne pathogens

occurs in different stages of food-processing, from farm to fork such as production in

farms, processing, packaging, shipping, storage, distribution, retail and consumption.

Food borne pathogens in food are a growing global concern, not only because of public

health issues and risks involved, but also because of the economic impact. Foodborne

illness remains a significant source of human disease despite numerous food safety

campaigns and educational efforts, along with decades of advancement in the field of

microbiology involving the study of pathogens of concern (Griffith, 2006). Recent food

safety failures that include food borne illness outbreaks due to pathogens, allergens,

mislabeling, and food fraud have attracted widespread attention resulting in public

mistrust over food industry and regulatory bodies. This mistrust allowed some producers

to build their business on widespread assumptions that smaller market-based, locally or

organically produced foods and foods from farmer markets were innately safer than foods manufactured by large companies. Microbiological food safety considerations are not inherent to such production methods (Powell, Jacob, & Chapman, 2011), yet the mistrust over food industry practices has been significantly higher than small market based, locally or organically produced foods.

Foodborne illness has been a significant concern for the high-risk populations of infants and young children, elderly people, and individuals with compromised immune systems. In 2010, the Center for Disease Control and Prevention (CDC) reported that the incidence of foodborne illness was highest in children younger than five years old (69.5 infections per 100,000 children), an estimated 5% of the infections were associated with traceable or known outbreaks; whereas, infected persons older than 60years old were reported to have the highest percentages of hospitalized cases and case-fatality ratios. With such risk involved with food borne pathogens in food products, it is imperative that food safety must be understood by everyone involved in the farm to fork supply chain. Failure to have good food safety programs could result in food recalls. In the next section, types of recalls, and their significance, are discussed in detail.

**Recalls – Impact on society:**

A recall is an imminent withdrawal of products by an organization from the market due to the contamination or the possibility of a potential risk to consumers. Recall is also considered as a procedure initiated and conducted by the responsible commercial firm to remove or correct a product in commerce. This decision to recall a product can be made by the firm itself or regulatory authorities when a product may be considered, or is

in violation of food laws. The total number of food recalls have increased in the last decade due to a renewed focus on food safety and quality of the product and also due to increased monitoring of products in the market place by regulatory bodies and independent watchdog organizations.

A food recall occurs when a firm removes their products from the marketplace due to concerns that the product may adversely affect consumer health (Teratanavat&Hooker, 2004). Food recalls can be two types. The first type of recall is called "market withdrawal", where the notifications focus on the voluntary removal of products that do not violate government regulations. Stock is recovered from distribution centers when firms voluntarily remove products yet to be distributed to consumers. A voluntary product recall can be considered to be the management approach of last resort to prevent unsafe products from being purchased and consumed by the public(Potter, Murray, Lawson, & Graham, 2012). The second type of recall is initiated by regulatory agencies (Teratanavat & Hooker, 2004). These cases are primarily initiated by regulatory bodies such as FDA, and USDA-FSIS after identification of an issue with the product.

Irrespective of the method of initiation, recalls are classified into three class levels based on their impact. The three class levels are explained below.

1. Class I recall:

The most severe classification is the Class I recall. In this recall there is a reasonable probability that the use of the product will cause serious adverse health consequences or death.

Examples of Class I recall:

a. Confirmed cases of *Clostridium botulinum* toxin in food;

b. *Listeria monocytogenes* in ready-to-eat foods;

c. All *Salmonella* in ready-to-eat foods; and,

d. Undeclared allergens such as a food with an ingredient that is a common cause of serious allergic reactions but is not labeled to indicate these contents.

2. Class II recall:

A Class II recall may occur when the use of the product could cause temporary or medically reversible adverse health consequences, or the probability of serious adverse health consequences is remote.

Examples of Class II recalls:

a. *Norovirus* contamination in seafood; and

b. Low levels of chemical contamination.

3. Class III recall:

A Class III recall is for products that do not meet federal regulations but are unlikely to cause adverse health consequences.

Examples of Class III recalls:

a. Incorrect weight or volume labeling;

b. Non-organic products being labeled as organic;

c. A food product that may have been produced under unsanitary conditions or that is decomposing; and,

d. A food that contains yeast or mold contamination except fresh breads.

According the Centers for Disease Control (CDC), food-borne illnesses cause about 300,000 hospitalizations and 5,000 deaths every year in the United States. Common causes are outbreaks of bacteria such as salmonella and E. coli. Awareness about food product safety within the food industry has improved in recent years due to a number of high profile food recalls (Chan & Lai, 2009; Kumar & Budin, 2006;Roth, Tsay, Pullman,& Gray, 2008; Warriner et al., 2009; Potter et al., 2012). The attempt to increase awareness has not helped to control recalls. In the last decade, there have been several recalls that have had a huge impact on society in the aspects of public health and economy. In the United States, it is estimated that the economy hemorrhages about $7 billion every year due to food recalls, food borne illness and outbreaks.

In 2010, the food industry experienced one of the largest food recalls in history when over 500 million eggs were recalled from White County Farms due to a *Salmonella* outbreak. The Jack-in-the-box recall incident can be considered as one of the most dramatic food borne illness outbreaks ever. The fast food restaurant chain sold hamburgers contaminated with *Escherichia coli O157:H7* in 1992. This led to sickness of hundreds of customers and the death of 4 children (Knight, Worosz, & Todd, 2007). Foodmaker Inc., the meat supplier to Jack-in-the-box, issued a recall in which they recovered about 20 percent of the affected beef. The supplier ended up losing approximately $160 million in sales and 30 percent of its stock market value as a result of the recall (Knight, Worosz & Todd, 2007).

In 1997, Hudson foods recalled 20 million pounds of ground beef. The recall was later expanded to 25 million pounds. The major effect was not direct recall costs, but the loss of Hudson's best customer, Burger King. Hudson foods sold the beef-processing

plant that was the source of the outbreak. Although the particular plant where the

contaminated beef was made was sold, the company suffered from brand name damage.

Tyson Foods offered to buy the company for $642 million, much less than it was worth a

year before the recall incident (Kumar & Budin, 2006). Figure 1.1 shows the total

number of recalls broken down by their causes from 2010-14.
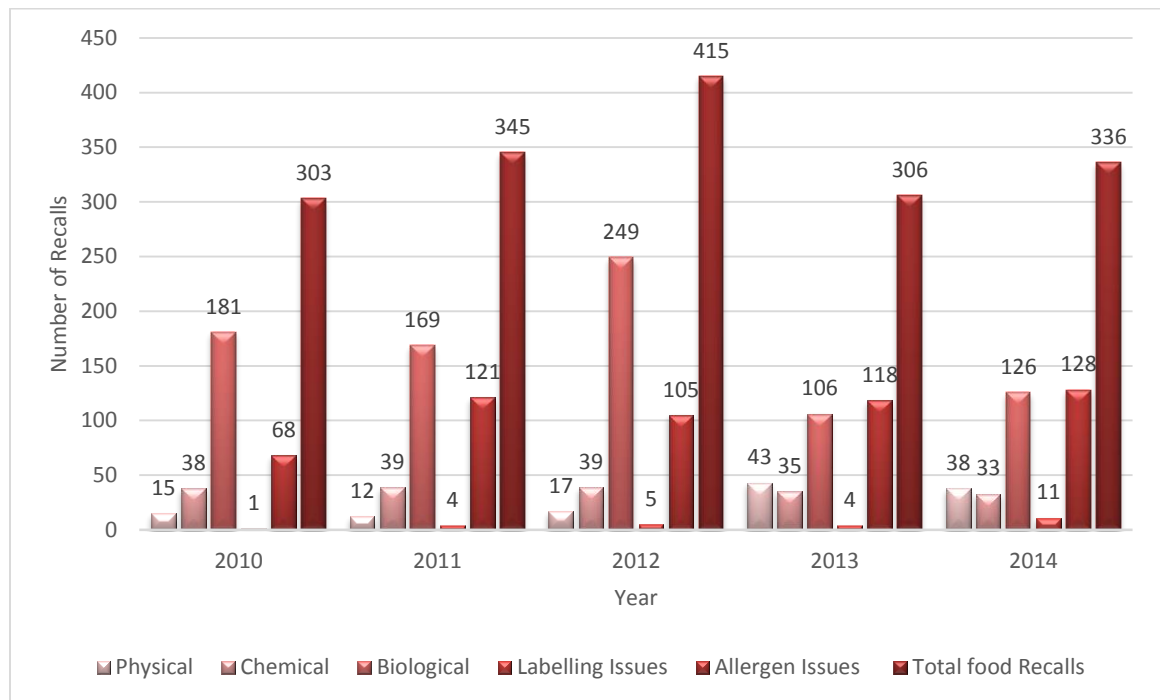


Fig 1.1 Graph showing the number of major recalls broken down by their causes from
2010-14.

The recall costs usually include the expenditures of getting food off the shelves,

handling lawsuits, over-hauling production plants and addressing public relations. These

expenses can sometimes go above and beyond what the organization can afford. Besides,

the critical aspect that takes a hard hit is the brand image and lost sales. It is very difficult

to estimate the loss of brand image in terms of money.

Product recalls have a substantial effect on firm performance. Detailed empirical research has found that product recalls can have a significant negative impact on firms across a range of performance measures, including operational performance (Hendricks & Singhal, 2005), share price (Salin& Hooker, 2001; Thomsen & McKenzie, 2001), customer sales (Thomsen, Shiptsova, & Hamm, 2006), consumer demand (Marsh, Schroeder & Mintert, 2004), market movements (Palma, Ribera, Bessler, Paggi, & Knutson, 2010), food prices, and prices on the futures market (Lusk & Schroeder, 2002).

The growing number of product recalls within the food industry has caused many to question the ability of retailers, producers and suppliers to provide safe products. The key patterns and longitudinal trends in the prevalence of food recalls in the USA, UK and the Republic of Ireland from 2004 to 2010 were reviewed by Potter et al. (2012). They identified a growing trend of product recalls within the food industry, with the majority of recalls detected by regulators rather than by suppliers, firms and distributors within the farm-to-fork supply chain. Considerable variations were also observed in the frequency of different recalls, with the processed food industry having the largest share of recalls, followed by the meat industry and then the fruit and vegetables industry.

It has been a strong belief that the biological hazards are the primary cause for recall. On the contrary, it was identified that operational hazards such as allergen issues and mislabeling issues are the most common cause of product recalls within the food industry (Potter et al, 2012). It is evident that the number of recalls has increased along with increasing efforts of regulatory bodies and manufacturers to improve food safety. As discussed earlier, it is not always the biological hazard, but the operational hazards such as mislabeling and allergen cross-contaminations that are the cause for recall in a

majority of the cases (Potter et al, 2012). Although operational issues such as mislabeling and allergen cross-contamination are not the root causes of recall associated with death of consumers as much as the microbiological issues, the financial damage caused to the organization due to operational issues is very high. In majority of the cases, the root causes of the issues are training, lack of information, knowledge and awareness over critical operational aspects. Considering these aspects, there is an imminent need to address the operational issues. There is vast information available through multiple sources such as academic institutions, private training bodies, and regulatory institutions to address the shortage of information to the processors. But, the food industry itself remains the greatest repository of knowledge about food safety management, food science-experience and expertise (Sperber, 2005). Hence, it is important to understand that the ultimate responsibility of food safety rests on food industry and they must improve their efforts to accept and abide by the legislation-based food safety policies. Food processing sectors must also use their intellectual assets to assert the leadership, as was done with initiation, development and advancement in HACCP (Sperber, 2005). To do so, collaboration between food safety professionals from industry, academia, regulatory agencies, third-party audit bodies, and students, (the future food safety professionals) is necessary.  It was indicated that in developing, installing, monitoring, verifying and validating a successful food safety and quality management system depends on a complex mix of managerial, organizational, and technical commitments (Taylor, 2001). Developing such quality management systems is critical for food growers and processors. This requirement calls for new platforms for learning, such as the

Oklahoma Audit Alliance, where multiple organizations come together to share best practices. In the next section, the concept of quality management is discussed in detail.

**Quality management in food industry**

The concept of product quality, just like food safety, is not obvious. Although not universally accepted, the definition for quality with a greater consensus among the food industry members, is suitability of the product for consumer use (Paiva, 2013). This definition is wide-ranging because it considers two major aspects of product and process:

1.  Product characteristics that lead to satisfaction with the quality of product; and
2.  The absence of failures in the product produced.

The key component consists of the quality characteristics of the product features that provide satisfaction and meet the needs of the consumer (Paiva, 2013).

Quality management has emerged as a management model for enhancing organizational effectiveness and competitiveness (Dow et al., 1999; Sanchez-Rodriguez and Martinez-Lorente, 2004). Several studies have suggested that firms achieve higher levels of profitability and organizational performance through successful implementation of practices associated with quality management (Powell, 1995; Das et al., 2000, Douglas and Judge, 2001; Kaynak, 2003; Mesut, 2009; Hendricks and Singhal, 2005; Kull and Narasimhan, 2010; Sadikoglu and Zehir, 2010). Multiple reports and interviews from the participants and winners of the Malcolm Baldrige National Quality Award (MBNQA) and other state level quality award participants support the statement that "commitment to

quality management and improvement systems helps overall organizational improvement in multiple aspects such as profitability, quality, improved customer satisfaction, decrease in product defects and decreased customer complaints". In view of this, the need for quality management and continuous improvement within food safety and product quality programs in food processing could help the organizations improve in critical aspects.

In this research project, an attempt was made to incorporate aspects of continuous improvement and learnings from MBNQA criteria to improve overall food safety and quality of food processing. A new criteria that integrates continuous improvement, quality management principles and food safety was developed and implemented through this project (Appendix A). The criteria developed was used as a tool to evaluate organizational commitment, while promoting best practice sharing. The evaluation was done through a new auditing approach encompassed in the "Oklahoma Audit Alliance". The OAA audit is a third-party audit. In the next section, different types of audit systems are discussed in detail.

**Third-party auditing:**

Auditing systems are classified into four types, as follows:

1. First-Party Auditing –Also called internal auditing/self-assessment.
2. Second-Party Auditing – Auditing by company paid, consultant(s).
3. Third-Party Auditing – Audits by independent organizations with expertise to provide as assessment and verification of company's compliance with established standards and legal and regulatory requirements.

4. Fourth-Party Auditing – Audits that are conducted by regulatory enforcement agencies (Tanner, 2000).

First-party auditing is a self-assessment of food safety and quality programs by employees within the organization. Frequency of the audits depends on the risk involved with the product and compliance trends of the food safety programs. Second-party auditing is a type of auditing conducted by an external consultant from an independent organization or the customers. Independent consultants are usually hired by organization to conduct the auditing process. Customer audits are conducted by an individual(s) with food safety experience that represents the customer. Third-party auditing is done by independent organizations with expertise to provide as assessment and verification of company's compliance with established standards, legal and regulatory requirements. Third-party audit schemes are implemented by an organization either voluntarily or per their customer's demand. The fourth-kind of audit is conducted by regulatory bodies such as the FDA and USDA-FSIS to verify compliance. All four types of audits are equally important and helps the organization to have a strong food safety and quality system which contributes to delivering safe and quality food to consumers.

With the changes in regulatory requirements (FSMA in 2015) and the development of new regulatory and verification mechanisms for the safety and quality of food and agricultural products in recent years, governance in the global food system has been significantly transformed (Hatanaka, Bain, & Busch, 2005). Traditionally, it was government agencies that were responsible for monitoring food safety standards and food quality attributes due to public health concerns. Although regulatory audits (FDA and USDA-FSIS) are in place, with emergence of customer required audits like BRC, SQF

and PRIMUS GAP, regulatory audits are not as prevalent as the organizations go through third-party and customer audits in the majority of the cases. Due to this reason, third-party certification procedures have gained greater importance both in local and the international food business sector. With such globalization of the food system, the merging of the food retail industry, and the rise in private retailer standards have triggered a shift in responsibility for this task to third-party certification bodies (Zuckerman, 1996; Barrientos et al., 2001; Bredahl et al., 2001; Calvin et al., 2001).

Different certification standards have been established to serve as instruments of food safety and quality assurance within the food supply chain (Deaton, 2004; Fulponi, 2006). Meuwissen and Huirne, (2000) state that the key feature of a certification system is that the inspections are carried out by independent third-party certification bodies in accordance with standards laid down by external organizations (Albersmeier, Schulze, Jahn, & Spiller, 2009) such as SQF, BRC and FSSC 22000 (Luning & Marcelis, 2006). These food safety audits are conducted by a professionally trained staff from food safety auditing bodies, also called certification bodies (CB). Food processing facilities which participate in audit programs receive a complete examination and technical assistance in all areas that affect food safety, product integrity, regulatory and other customer requirements.

Typically, the process of obtaining third-party certification operates in the following sequence. First, a supplier applies to a particular third-party certification body for certification. The third-party certification body conducts an optional pre assessment and documentation review of a supplier's facilities and operations. Field audits are also conducted verifying the conformity to the organizational policies and procedures

established based on the food safety schemes criteria. When the conformity is verified, the certification body issues a certification and allows the supplier to label its products as certified. The flow chart below shows the step by step process involved in achieving a third-party certification.

```
        ┌─────────────────────────────┐
        │ Decide Certification Scheme │
        └─────────────────────────────┘
                      │
                      ▼
    ┌─────────────────────────────────────┐
    │ Develop, Implement, Verify and Improve│
    │ policies to comply with scheme requirements│
    └─────────────────────────────────────┘
                      │
                      ▼
    ┌─────────────────────────────────────┐
    │      Contact certification body     │
    └─────────────────────────────────────┘
                      │
                      ▼
    ┌─────────────────────────────────────┐
    │ Schedule audit – Site audit & Document audit│
    └─────────────────────────────────────┘
                      │
                      ▼
    ┌─────────────────────────────────────┐
    │ Address non conformities found during audit│
    └─────────────────────────────────────┘
                      │
                      ▼
        ┌─────────────────────────────┐
        │     Achieve certification   │
        └─────────────────────────────┘
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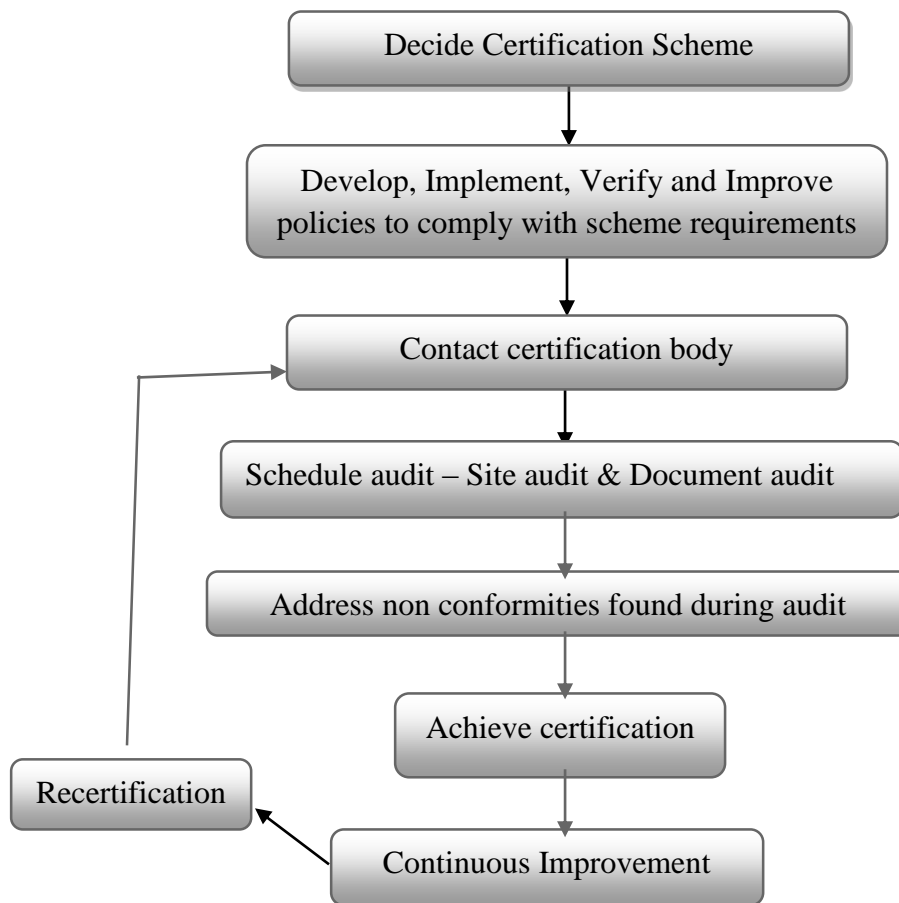
Fig 2.3: Flow chart showing third-party audit certification process

There are a number of reasons why third-party audits are requested. These include but are not limited to the following:

- Desire to improve food safety, quality and sanitation
- Customer requirement to verify a vendor's programs

- Potential marketing advantage

- Troubleshooting

- Insufficient in-house resources

The certification process is expected to provide assurances about a product to customers or stakeholders by inspecting processes involved in the production life cycle. The best aspect about the third-party certification process is the claimed independence from other participants involved in food or agricultural production such as retailers or suppliers. The processor holds the responsibility of the product that is shipped out from their facility (Zuckerman, 1996). Third-party certification processes also emphasizes values such as independence, objective evidence, and transparency in an attempt to increase trust and legitimacy among customers. With this approach in the supply chain, where every supplier takes responsibility for product safety, the overall safety of the food supply chain increases.

The major draw backs involved in third-party certification process are the duration of audit and costs associated with the process. Most of the third-party audits are conducted for 2 days during which the auditor verifies the compliance against the audit criteria. This verification activities includes records verification and facility processes verification. In most cases, it is nearly impossible to verify all records and processes in two days. Regarding the costs involved with third-party audit process, justification can be made by countering with the recall costs. It is important to identify, understand and implement cost-effective approaches that are specific to products being processed. This can be achieved by having a methodology to share the best practices within the supply chain as the food industry will always be the primary repository for food-safety

information. It is also important that any information that helps people involved in the food production, packing, distribution and sales sectors must be made open-source and readily available. A culture of food safety is not limited to a strong food safety certification scheme. The concept of organizational food safety culture and its importance is discussed in detail in the next section.

**Food safety – A culture in food industry**

A culture of food safety is built on a set of shared values that the organizational employees follow to produce and provide food in the safest manner (Powell et al., 2011). Maintaining a food safety culture means that all the employees such as top management, mid-level managers, supervisors, operators and staff are made aware of the risks associated with the products they produce. They also must understand the importance of managing the risks, and continuously improve their abilities to effectively manage those risks in a demonstrable fashion with actionable information. It is important for any organization to realize that they must get employees trained and provide sufficient resources to improve their skills to implement food safety practices before the organization can establish a strong food safety culture. In an organization trying to achieve a good food safety culture, each employee is expected to implement the best practices that represent the shared value system and point out where others may fail (Powell et al., 2011). Organizations can demonstrate a good food-safety culture by utilization of a wide variety of tools, consequences and incentives to improve food safety programs. Awareness of current food safety issues reflects the effects by organization to stay up to date and continuously improve food safety programs (Powell et al., 2011).

According to Frank Yiannas, organizational success in food safety depends on: "Going beyond traditional training, testing, and inspectional approaches to managing risks. It requires a better understanding of organizational culture and the human dimensions of food safety. To improve the food safety performance of retail or foodservice establishment, an organization with thousands of employees, or a local community, you must change the way people do things. You must change their behavior. In fact, simply put, often times food safety equals behavior" (Yiannas, 2009).

Other aspects of food safety culture that directly contribute to food safety performance are leadership, food safety management systems and style, commitment to food safety, environment, perception of risk involved with products, communication among employees, and communication within the supply chain. Understanding what these aspects mean and identifying and implementing the best strategies to promote food safety as a culture, instead of a regulatory requirement, is very important.

The process by which the current food safety systems and the HACCP system evolved was simultaneous and transparent (Sperber, 2005). With respect to the process of evolution of current food safety systems to the current standards, various aspects such as voluntary systems based on science and mandatory systems based on legislation were considered. Both GFSI and legislation (FDA & USDA-FSIS) based systems are providing greater transparency in the improvement of food safety management systems. Greater transparency in food safety practices will promote commitment levels of employees within organization which in turn lays a great foundation for a strong food safety culture.

Organizational culture is a concept that describes how employees view their organization and how certain work practices are handled and the organizational attitude and approach. Chatman, Polzer, Barsade, & Neale, (1998) referred to organizational culture as a system of shared meaning that members of an organization hold and that distinguishes one organization from another. This system of shared meaning can be represented by a set of key characteristics that the majority of the organizations and individuals perceive as core values. Some of these characteristics are risk taking, attention to detail, team orientation, outcome orientation, and aggressiveness (Sheridan, 1992; O'Reilly, Chatman, & Caldwell, 1991).

James et al. (1989) defined organizational culture as a concept that encompasses a range of individual evaluations of the work environment. Evaluations refer to general perceptions of aspects such as leadership, management style or communication, or to specific perceptions such as the safety or innovation culture (Klein et al, 1996; Flin, 2007; Guldenmund, 2007). Also, organizational culture can involve assessment of an organization at two different levels. First, a general level as represented by a standard; and second, a specific level as it relates to a particular work task within the organization. The concept of culture must be taken to mean something more complex than the organizational "climate" of a firm. Research suggests that a strong food safety climate provides a surface view of employee attitudes toward food safety at a given point in time, which could represent the prevailing food safety culture within the organization. Culture is difficult to measure, whereas safety climate can be traced more easily (Griffin & Neal, 2000).

The impact of organizational culture on employee food safety practices has been studied. The influence of a range of behavioral factors supporting transfer of food-safety training to food-safety performance was studied (Frash & MacLaurin, 2010). The findings revealed that employee perceptions towards organizational culture differed based on their job positions. Observations suggested that a heterogeneous culture exists within an organization and the assessment of food-safety culture should be measured separately.

Lee et al. (2012) studied the influence of organization culture and transformational leadership on employee attitude and intention to follow safety practices. It was observed that the organizational culture showed a significant effect on attitude and intention, while transformational leadership influenced organizational culture and not the attitude and intention. The study also suggested that food safety certification moderates the relationship between organizational culture and attitude and intention toward food safety. This study by Lee et al. (2012) implied that there was a significant difference in relationship between employee perception of organizational culture and employee attitude and intention for those with and without safety certification.

Food-safety culture is something that differentiates a great organization and an average organization. The strong assumptions within the average organization with respect to the behavioral aspects are as follows:

1. Optimistic bias - It will not happen to me;

2. Illusion of control - Everything is going just fine or nothing has gone wrong because I know what I am doing; and,

3. Cognitive dissonance: The belief that employees know that they are doing wrong but there is a reason and attitudinal ambivalence which means, employees think that there are more important matters (Souza Monteiro, 2009).

A good company will always finds a way to overcome the traits that hinder them from moving forward, or prevent them from having a strong food-safety culture.

The following are some crucial aspects to be considered by an organization that is trying to develop a strong internal food-safety culture (Yiannas, 2009).

1. A system based approach towards food safety, creating, implementing, verifying and reacting to food safety performance expectations;

2. Working towards developing expectations beyond risk basis;

3. Thinking beyond regulatory requirement;

4. Providing appropriate training, education to influence behavior;

5. Focus on changing behaviors;

6. Developing food safety goals and measurement mechanisms;

7. Using consequence based approach to promote change of behavior; and,

8. Tying the all the aspects together and taking a collective approach driving traditional food safety management systems towards a behavior based food-safety management system, in other words, a food-safety culture.

Although there are several resources for passive learning about food-safety culture, the food industry itself acts as the greatest resource for information, experience and cost-effective best practices. For this reason, there is an imminent requirement for

establishing a platform to promote best practice sharing methods within the food industry. The values revolving around "best practice sharing", which itself is a great core value for any business, has been one of the greatest advantages of participating in Malcolm Baldrige National Quality Award (MBNQA). In the next few paragraphs, MBNQA and how its core values can be used in the food industry to enhance food-safety knowledge with in the industry is discussed.

**Malcolm Baldrige National Quality Award:**

America's highest honor for innovation and performance excellence, the Baldrige Award, is presented annually to American organizations by the President of the United States. The award recognizes U.S. companies for their achievements in quality and business performance. The Malcolm Baldrige National Quality Award was established in 1987 with the signing of the National Quality Improvement Act of 1987 by President Ronald Reagan (Hodgetts, 1994). The primary purpose for establishing this award was to promote quality awareness and innovation and to promote the consideration of innovative methods to improve businesses and sharing of these successful strategies to organizations in United States (Hodgetts, 1994). By implementing this quality award, improvement in quality became evident as the industry experts and government leaders noticed American companies made quality performance a prerequisite for their businesses in expanding in the competitive market.

The award was named after Mr. Malcolm Baldrige who was the Secretary of Commerce from 1981 until his tragic death in a rodeo accident in 1987. Baldrige was a proponent of quality management and believed it was the key to the America's prosperity

and strength in business. He was a leader in business and management and the one who wrote and established the quality improvement act which was eventually named after him.

The awards are given annually under the following categories:

1. Manufacturing companies or subsidiaries.

2. Service companies or subsidiaries.

3. Small businesses.

4. Health care.

5. Non-profit organizations.

Any business with headquarters in the United States or its territories, may apply for the award, including United States subsidiaries of any foreign companies. Criteria for an organization to fall into the category of "small business" is that it must be independently owned with not more than 500 full-time employees. Organizations with employees greater than 500 are considered to be "large companies" (NIST 2010).

All the applicants are audited by auditors, also called examiners, based on award criteria and an observational report is compiled. The report is then reviewed by judges and a final report is provided to the applicant. The majority of the participants have reported that the final report received through participation in the MBNQA as the most valuable aspect of whole process as it provides information about both positive and negative aspects of the organization.

The Baldrige criteria is comprised of 7 sections along with an organizational profile. These sections are well-connected to the core values of the Baldrige criteria. Figure 2.2 shows the framework of the Baldrige Award and the role of core values and concepts.
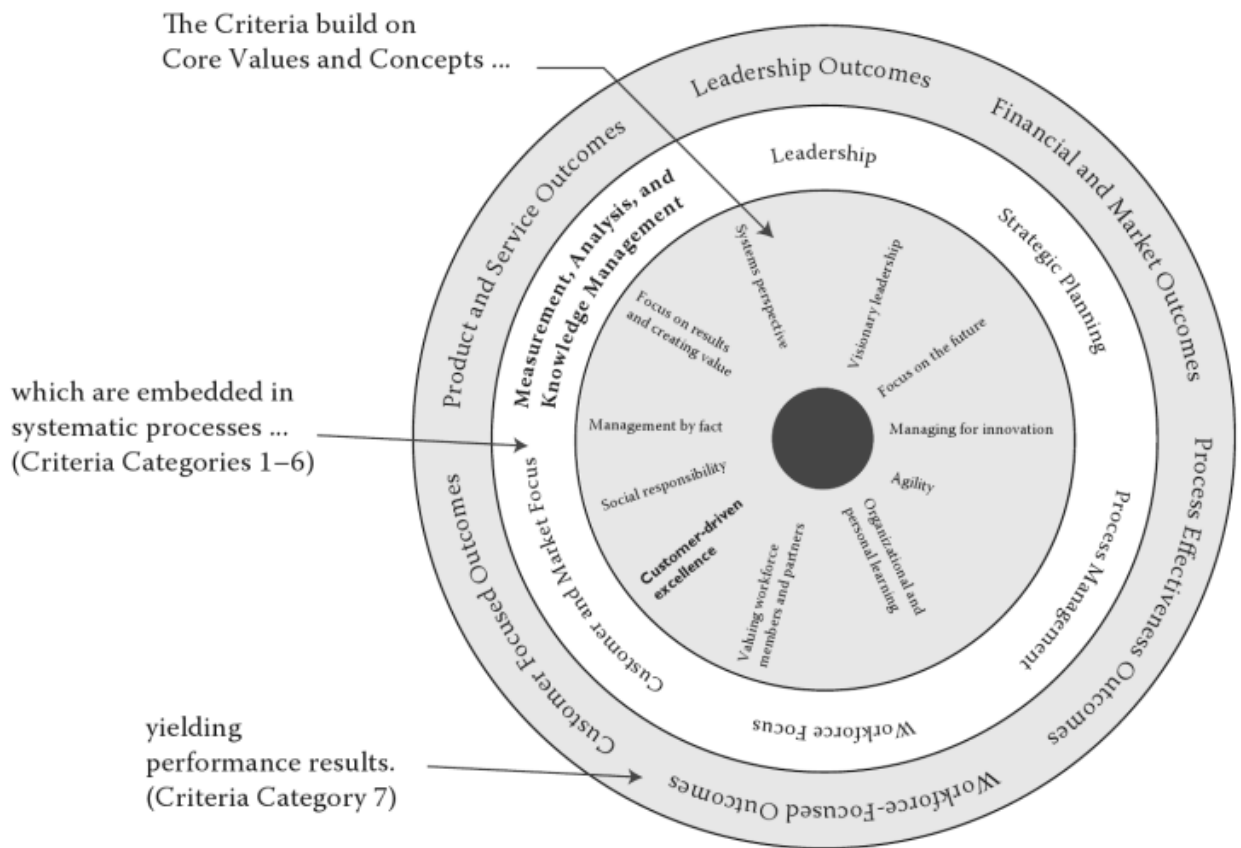


Fig 2.2 Figure showing the core values of MBNQA, their roles and concepts (Brown 2013).

As shown in the figure 2.2, the criteria is built on the following core values and concepts.

1. Visionary leadership;

2. Focus on future;

3. Managing for innovation;

4. Agility;

5. Organizational and personal learning;

6. Valuing workforce members and partners;

7. Customer-driven excellence;

8. Social responsibility;

9. Management by fact;

10. Focus on results and creating value; and,

11. System prospective.

These core values and concepts are embedded in systematic processes into 6 sections that are listed below:

1. Leadership;

2. Strategic planning;

3. Process management;

4. Workforce focus;

5. Customer and market focus; and,

6. Measurement, analysis and knowledge management.

These 6 sections yields performance results that are expected to be reported in category 7. Category 7 consists of organizational results in the following areas:

1. Leadership outcomes;

2. Financial market outcomes;

3. Process effectiveness outcomes;

4. Workforce focused outcomes;

5. Customer focused outcomes; and,

6. Product and service outcomes.

These seven categories make up a complete Baldrige Award criteria. These criteria are the basis for choosing the award recipients and were designed to enhance competitiveness.  More importantly these criteria provide a framework (shown in Figure 2.3) that an organization can use to improve overall performance.

**Baldrige Criteria for Performance Excellence Framework**
**A Systems Perspective**

Organizational Profile:
Environment, Relationships, and Strategic Situation

2
Strategic
Planning

5
Workforce
Focus

1
Leadership

7
Results

3
Customer
Focus

6
Operations
Focus

4
Measurement, Analysis, and Knowledge Management

Fig 2.3. A figure showing Baldrige criteria for performance excellence framework – A systems perspective (NIST, 2010).

In the process of evaluating an organization using Malcolm Baldrige Performance Evaluation Criteria (MBPEC), information specific to the concepts mentioned in the above framework are described in a 50-page application submitted by the organization. In the application, the organizational profile sets the context for the operation of the participating organization. It serves as a guide for the performance management system. The leadership triangle (Leadership, Strategic Planning, and Customer Focus) emphasizes the importance of a leadership focus on strategy and customers. Leaders are expected to set the direction and seek future opportunities for the organization (Brown,

2013). The results triangle (Workforce Focus, Operations Focus, and Results) includes workforce focused processes, organizational key operational processes, and the performance results obtained. The system foundation (Measurement, Analysis, and Knowledge Management) is critical to effective management and to a fact-based, knowledge-driven system for improving performance and competitiveness(Prybutok, Zhang, & Peak, 2011).

The criteria for the MBPEC follow:

1.  Leadership - Examines how senior executives guide the company, how the company addresses its responsibilities to the public and how the company practices good citizenship.

2.  Strategic Planning - Examines how the company sets strategic directions and how it determines key action plans.

3.  Customer focus - Examines how the company determines requirements and expectations of customers and markets.

4.  Measurement, Analysis and Knowledge Management - Examines the management, effective use, and analysis of data and information to support key company processes and the company's performance management system.

5.  Workforce focus - Examines how the company enables its workforce to develop its full potential and how the workforce is aligned with the company's objectives.

6.  Operation focus - Examines aspects of how key production, delivery, and support processes are designed, managed, and improved.

7.  Results - Examines the company's performance and improvement in the key business areas of customer satisfaction, financial and marketplace performance,

human resources, supplier and partner performance, and operational performance. This category also examines how the company performs relative to their direct competitors.

MBNQA process:

The MBNQA process involves each participant filling out and submitting an application which is evaluated by the members of the Board of Examiners. The Board of Examiners is comprised of multiple quality experts selected from industry, professional and trade organizations, universities, government agencies, education and healthcare, and participating organizations. Examiners look for achievements and improvements in all seven categories of the Baldrige criteria. Using the guidelines, the organizations are scored based on their performance and how well they meet the criteria. High scoring applicants are selected for site visits by a panel of judges. The judges verify information in the application and clarify questions during the review. The judges recommend award recipients to the Secretary of Commerce from among the applicants' site visited. Each applicant receives a written feedback summary of strengths and opportunities for improvement in each area addressed by the criteria (Brown, 2013).

One interesting aspect about the MBNQA program is that the participants don't necessarily apply for the rewards or recognition, but for a thorough evaluation of their organization and the organizational practices. The application and review process has been quoted as being the best and most cost effective and comprehensive audit any organization can possibly obtain. Multiple organizations have used the Baldrige Award performance excellence criteria to assess and improve their company.

Not only can companies get audited at a bargain price but also receive information from the winning organizations. They can adopt quality programs that they can use for their own needs (which is the whole idea of best practice sharing) and benefit each other. Sharing best practices and presenting the successful quality programs has been a major part of the award even though the requirements are limited.

**Advantages of the Baldrige program:**

There are several advantages of participating in the Baldrige program. Listed below are some of the key advantages reported in multiple publications:

1. The Baldrige program promotes organizational culture transformation by focusing on the workforce and all plans and objectives on the mission and vision of the organization. This approach uncovers core values, strengths and weaknesses, and promotes learning and improvement organization wide through self-assessments and external, independent examiner feedback (Brown 2013).

2. It complements approaches such as lean and Six-Sigma. While other tools and approaches focus on a single aspect, such as eliminating waste or defects, the Baldrige criteria address all factors that affect the organization, its operations and its results which is achieved by a very holistic approach in which the Baldrige model is divided into seven categories: workforce, customers, leadership, strategic planning, process management, measurement and results (Agarwal et al 2013).

3. The criteria also serve as a tool to integrate and organize other quality approaches an organization uses. Organizations could use this framework to develop an overall opinion on strength of performance and determine areas that need

improvement and then use Six-Sigma tools, and lean principles to design operations or improve processes.

4. The Baldrige criteria is very well known to set the bar higher. With the business dimensions changing constantly and creating a competitive business climate, organizations must find way to go beyond compliance and conformity-based systems. The Baldrige criteria places emphasis on competitiveness, benchmarking, understanding performance, results and maintaining a future focus (Agarwal et al 2013)

5. Hendricks & Singhal, (2005) reported that the stock value of Baldrige winner has increased over the years along with their overall performance.

Following are some of the highlights of the program:

1. State and local quality programs, most modeled after the Baldrige program, have grown from fewer than 10 in 1991 to more than 40 active programs based in states throughout the country.

2. Internationally, nearly 80 quality programs are currently operating. Most are modeled after the Baldrige program, including one established in Japan in 1996.

3. Since 1988, over 1,500 applications have been submitted for the Baldrige Award from a wide variety of types and sizes of organizations.

The use of Baldrige approach has been reported to be very successful. In the aspects of food safety, the approach involving best practices is not prevalent or may be nonexistent. In this project, creating such a platform to share best practices is the primary objective and also the core concept behind the entire audit alliance program. In the OAA

program, food safety and quality programs were linked with Baldrige core values and a new criteria was developed. The idea was to have a platform for knowledge transfer across the food industry by promoting the idea of best practice sharing within the food industry. To achieve this, audit training and conducting an actual audit using GFSI and FSQ criteria were used. This OAA process effectiveness was evaluated using a training evaluation method developed by Kirkpatrick (1976). In the next section, Kirkpatrick evaluation method is discussed in detail.

**Kirkpatrick method of evaluation:**

Kirkpatrick's four-level model is the most widely used model of training used in the industry and is considered an industry standard among the human resources and training departments. The Kirkpatrick evaluation model was used to determine the effectiveness of the OAA program. An evaluation is a systematic process that can be used to determine the worth, value, or meaning of an activity or process (Phillips, 1997). According to Kirkpatrick (1998) the evaluation process consists of a series of four levels. The levels, in order, are reaction, learning, behavior, and results. The first level is the reaction level in which the reactions of the trainees are understood to mean the way in which they perceive and subjectively evaluate the relevance and quality of the training. According to Kirkpatrick (1998), every program should at least be evaluated at this level to provide for the improvement of a training program. At the first level, evaluation measures the satisfaction of the people who followed the training. Learning can be described as the extent to which the attitudes of the participants change, their knowledge increases or their skills are broadened as a consequence of the training. A third evaluation level is that of changes in job behavior or performance. This involves studying the

change in job behavior which takes place as a result of the training. Level four evaluation attempts to assess training in terms of organizational results.

Phillips (1991) stated the Kirkpatrick Model was probably the most well-known framework for classifying areas of evaluation. Survey results indicated the majority (81%) of human resources executives attached some level of importance to evaluation and over half (67%) used the Kirkpatrick model (ASTD, 1997). The Kirkpatrick model was assessed as a valuable framework designed with four levels of measure to evaluate the effectiveness of an Educational training. The most influential framework for the evaluation of training programs has come from Kirkpatrick, Kirkpatrick method follows a goal-based approach (Dixon, 1996; Gorden 1991; Phillips, 1991; Kirkpatrick, 1959). The four levels of the model are discussed below in detail (Kirkpatrick 1976).

Table 2.1 shows the Kirkpatrick's evaluation structure with an example evaluation, relevance and practicability.

Table 2.1. Kirkpatrick's evaluation structure showing an example evaluation, relevance and practicability.

| Level | Evaluation type | Evaluation description and characteristics | Evaluation tools and methods (Examples) | Relevance and practicability |
|-------|-----------------|---------------------------------------------|------------------------------------------|------------------------------|
| 1 | Reaction | Reaction evaluation: How the trainees felt about the training | Feedback forms. Verbal reaction, Post-training surveys Questionnaires. | Quick and very easy to obtain. Not expensive to gather information. |
| 2 | Learning | Learning evaluation: Measurement of the increase in knowledge - before and after training. | Typically assessments or tests before and after the training. Interview or observation can be used. | Relatively simple to set up. Not an easy level for complex learning. |
| 3 | Behavior | Behavior evaluation: Extent or ability of applied learning back on the job. | Observation Interviews Questionnaires to assess the implementation of learning. | Depending on method used for measurement, it could be expensive to collect required information. |
| 4 | Results | Results evaluation: Impact of training on performance | Direct measurement of productivity. | Individually not difficult. It is not easy to relate directly to the trainee. |

Level one includes assessment of reaction to the training program in terms of how well participants liked a particular program. The common measures at this level are most commonly directed at assessing trainees' affective responses to the quality such as satisfaction with the instructor or the relevance or work-related utility of information provided during the training. Learning measures are quantifiable indicators that the learning that has taken place during the course of the training; whereas behavior

outcomes address either the extent to which knowledge and skills gained in training would be applied on the job or results in exceptional job performance (Bates, 2004). Level four outcomes are intended to provide some measure of the impact training on broader organizational goals and objectives which typically has been on organizational level financial measures (Bates, 2004).

Advantages:

Bates (2004) discussed several advantages of using Kirkpatrick method of evaluation.

- The Kirkpatrick model served as the primary organizing design for training evaluations in for-profit organizations for over 30 years.

- The model addressed the need of training professionals to understand training evaluation in a systematic way (Shelton & Alliger, 1993).

- Information about level four outcomes is perhaps the most valuable or descriptive information about training that can be obtained.

- For training professionals in organizations this bottom-line focus is seen as a good fit with the competitive profit orientation of their sponsors. The four-level model has provided a means for trainers in organizations to couch the results of what they do in business terms.

- The popularity of the four-level model is also a function of its potential for simplifying the complex process of training evaluation. The model does this in several ways.

o The model represents a straightforward guide about the kinds of questions that should be asked and the criteria that may be appropriate.

o The model reduces the measurement demands for training evaluation. Since the model focuses the evaluation process on four classes of outcome data that are generally collected after the training has been completed it eliminates the need for pre-course measures of learning or job performance measures are not essential for determining program effectiveness (Bates, 2004).

o In addition, because conclusions about training effectiveness are based solely on outcome measures, the model greatly reduces the number of variables with which training evaluators need to be concerned. In effect, the model eliminates the need to measure or account for the complex network of factors that surround and interact with the training process.

- The model promoted awareness of the importance of thinking about and assessing training in business terms (Wang, 2003). The distinction between learning (level two) and behavior (level three) has drawn increased attention to the importance of the learning transfer process in making training truly effective.

- The model not only served as a useful tool for training evaluators and has been the seed from which a number of other evaluation models have germinated (Holton, 1996).

Limitations of the four-level model:

There are at least three limitations of Kirkpatrick's model that have implications for the ability of training evaluators to deliver benefits and extend the interests of organizational clients (Bates, 2004).

1. The incompleteness of the model, the assumption of causality, and the assumption of increasing importance of information as the levels of outcomes are ascended.

2. The four-level model is sometimes viewed as an oversimplified view of training effectiveness that does not consider individual or contextual influences in the evaluation of training.

3. A broad stream of research over past two decades (Ford et al, 1995; Salas et al, 2001) has documented the presence of a wide range of organizational, individual, and training design and delivery factors that can influence training effectiveness before, during, or after training. This research has led to a new understanding of training effectiveness that considers 'characteristics of the organization and work environment and characteristics of the individual trainee as crucial input factors. For example, contextual factors such as the learning culture of the organization, organizational or work unit goals and values, the nature of interpersonal support in the workplace for skill acquisition and behavior change, the climate for learning transfer, and the adequacy of material resources have been shown to influence the effectiveness of both process and outcomes of training(Bates, 2004; Kraiger et al, 1995; Tracy et al, 1995; Ford et al, 1992; Bates et al 2000; Rouiller & Goldstein, 1993 ).

In this project, the Kirkpatrick method of evaluation (level 3) is used to evaluate the audit alliance process. The primary expectation from the participants was to be trained in auditing processes, learn the best practices form participating organization and implement the learning. Three different sets of questionnaires were developed to assess the effectiveness of the program. Questionnaire responses were evaluated using descriptive statistics and a non-parametric statistical test to assess the significance of an increase in knowledge, awareness and understanding level on food safety, quality and continuous improvement programs of participants by participation in the OAA program. In the next section, rationale behind using Mann-Whitney-Wilcoxon test, a non-parametric test, is discussed in detail.

**Statistical method- Mann-Whitney – Wilcoxon test:**

For the purpose of statistical analysis, the mean, standard deviation and ranges of scores for the responses are reported. In the process of testing the three aspects of the Kirkpatrick method, similar questions were asked about the understanding of food safety, quality and continuous improvement in order to observe the impact of this program on participants. Three aspects were considered and it was hypothesized that there was a significant impact on participants' awareness, knowledge and understanding of food safety, quality and continuous improvement programs by participating in this program.

The target population considered was the employees and students from the state of Oklahoma with significant interest in food safety and quality. Students with an academic major in food safety were recruited and trained appropriately. Due to the unique requirements for participation, the sample size was n=19. For this reason, it was

evident that the normal distribution of assumptions cannot be made for hypothesis testing. For the samples, post training/participation and pre training/participation, $n \leq 19$ and $n_1 \neq n_2$.

There are numerous statistical tests for deciding whether there is a significant difference between two samples from same distribution sample. For samples with a normal distribution, the two-sample t-test was used, which could be termed as a "parametric test" (Wijnand & van de Velde, 2000). In the situations where the underlying distribution is not normal, and cannot be made normal by some suitable transformation, a "non-parametric" two sample test may offer advantages such as a higher relative efficiency (Wijnand & van de Velde, 2000). Certain assumptions must be made in such cases and are: both samples are random samples from their respective populations; there is independence within each sample; and, the samples are mutually independent.

Xie and Priebe (2002) stated that the fundamental problem in nonparametric statistics is deciding whether a new treatment constitutes an improvement over some standard treatment. The problem of comparing two treatments is divided into two categories such as the one-sample problem and the two-sample problem. In the two-sample problem, a random sample is drawn for each of two treatments. Among the available non-parametric testing methods, Mann Whitney–Wilcoxon statistic (Wilcoxon, 1945; Mann and Whitney, 1947) and the Wilcoxon signed rank (WSR) statistic (Wilcoxon, 1945) are stated to be the best suitable for small sample sizes.

Among those two tests, the Wilcoxon-Mann-Whitney test is the best non-parametric analog to the independent samples t-test and can be used when the assumption that the

dependent variable is not normally distributed. Wilcoxon (1945) introduced a nonparametric two-sample test for samples of equal size. Later, Mann and Whitney (1947) explored the case of unequal sample sizes to provide tables of critical rank sums for relatively small sample sizes which has been the basis for the widespread use of the nonparametric two-sample test under limited circumstances and small samples. In this dissertation, the Mann-Whitney-Wilcoxon test is used as it is the best-suitable non-parametric test for the small sample size available for the study.

CHAPTER III

Materials and Methods

In this chapter, the materials required and the methodology of the project development, implementation and analysis of effectiveness are discussed. As the topic chosen was abstract, the number of methods available were limited. The primary objective of this project was to develop and implement a methodology to share best practices among food safety practitioners. To achieve this, the OAA was formed and an audit criteria was developed focusing on food safety, quality and continuous improvement. Multiple documents were used for the audit purposes depending on the stage of the project. Training material was developed that covered internal audit training, auditor ethics, introduction to third-party auditing, introduction to MBNQA, and the OAA audit approach. Third-party audit criteria such as BRC, SQF and PRIMUS GAP were used for the internal auditing purpose. For the evaluation of the program, three different questionnaires were developed. The next few sections elaborate on the methodology after which a complete list of documents (materials) that were created and used throughout the project are listed in Table 3.1.

**Project steps and approach:**

The flow chart below shows the major phases involved in the project.

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                    ┌──────────────────────────────┐
                    │   Oklahoma Audit Alliance     │
                    └──────────────────────────────┘

   ┌───────────────────────┐          ┌───────────────────────┐
   │      Phase: 1          │          │      Phase: 2          │
   │  Project Development    │          │ Project Implementation │
   └───────────────────────┘          └───────────────────────┘
              │                                   │
              ▼                                   ▼
   ┌───────────────────────┐          ┌───────────────────────┐
   │ Development of Criteria │          │ Training the members of│
   │  – FAPC FSQ Criteria    │          │     audit alliance     │
   └───────────────────────┘          └───────────────────────┘
              │                                   │
              ▼                                   ▼
   ┌───────────────────────┐          ┌───────────────────────┐
   │ Notification and outreach│         │      Onsite audit      │
   └───────────────────────┘          └───────────────────────┘
              │                                   │
              ▼                                   ▼
   ┌───────────────────────┐          ┌───────────────────────┐
   │  Formation of audit     │          │  Audit analysis: Audit │
   │      alliance           │          │     report review      │
   └───────────────────────┘          └───────────────────────┘
                                                  │
                                                  ▼
                                       ┌───────────────────────┐
                                       │ Testing the effectiveness of OAA │
                                       └───────────────────────┘
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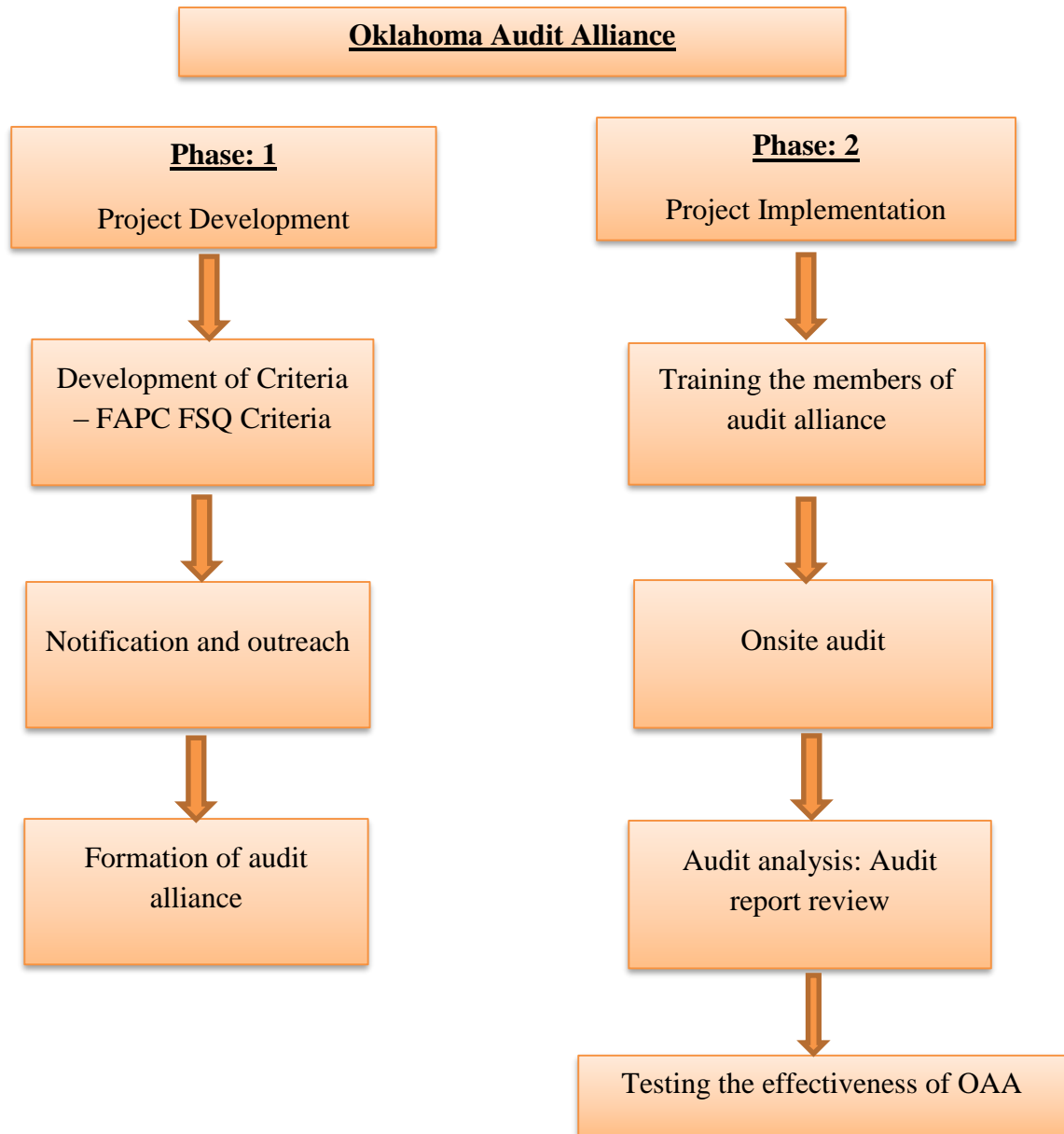
Fig 3.1: Flow chart showing phases to implement the Oklahoma Audit Alliance.

**Oklahoma Audit Alliance:**

In the process of the development of methodology to promote sharing of successful food safety, quality and continuous improvement strategies, the OAA was initiated and implemented in the food processing sector of Oklahoma. The methods developed for the project are discussed below.

The OAA project included two phases: development; and implementation. The development phase involved the generation of a Food Safety and Quality (FSQ) criteria and the adoption of a GFSI scheme criteria relevant to the program, notification, outreach and formation of the audit alliance. The implementation phase consisted of training the audit alliance team, conducting an onsite audit, and preparing an audit report review and analysis. Effectiveness testing was completed at the end of each phase.

**Phase 1 – Project Development:**

1. **Development of audit criteria:**

The OAA audit criteria had two different audit schemes: FSQ Criteria, and the adapted GFSI scheme criteria relevant to the program. The details about both criteria are provided below.

   a) FAPC FSQ Criteria:

The organizations were audited against criteria with a numerical scoring system to evaluate food safety and quality parameters along with continuous improvement strategies practiced to achieve performance excellence. This criterion helped to evaluate

the strategic quality improvement practices and identify a common ground for the organizations to compare and learn best practices through the auditing process.

FSQ criterion was developed for the study based on the core values in the lines of "Malcolm Baldrige Performance Excellence Criteria" (MBPEC) (Agarwal et al, 2013) but primarily focusing on food safety and performance improvement such as:

- Management commitment;

- Strategic planning;

- Knowledge management;

- Continuous improvement methods;

- Customer Management; and,

- Employee Management.

A scoring system was derived for the evaluation of the organization's systems against this criteria. This scoring system helped to achieve a quantitative comparison of the listed food safety, product quality and continuous improvement methods of the organization.

b) GFSI schemes Criteria:

The GFSI scheme criterion was focused on assessment of the specific GFSI scheme (BRC, SQF and PRIMUS GAP) that was implemented by the organization. One of the GFSI benchmarked schemes (FSSC22000, BRC, SQF, PRIMUS and Global GAP) that were being implemented by the participating organization were adopted and used for

the audit purposes. The criteria were developed and adopted to help organizations reassess the existing GFSI scheme along with other important aspects of food safety and quality systems. This audit process was expected to help the companies partially meet the annual internal audit criteria according to the GFSI benchmarked schemes. This process was also expected to provide an outside perspective on the effectiveness of organization's existing food safety and quality policies and procedures.

The GFSI schemes may include but were not limited to the following:

- British Retail Consortium (BRC);

- Safe Quality Foods (SQF);

- Primus GFS – A Global Food Safety Initiative Scheme;

- Food Safety Systems Certification 22000 (FSSC 22000);

- Global GAP (Good Agricultural Practices); and,

- Other GFSI benchmarked schemes that were implemented by organizations that were part of OAA.

2. **Notification and outreach:**

Communication was a key factor that contributed to the success of the project. Good communication with the industry was achieved with the help of the Food and Agriculture Products Center (FAPC) marketing team, the FAPC quality management team, and the author. Outreach was carried out via the FAPC website, FAPC flash emails, communication through workshops conducted at FAPC (about 15 annually), the FAPC

newsletter, and the announcement during an industry quality roundtable. On-site meetings with the participating organizations were also arranged in order to meet the management teams and to help them understand the importance of being a member of the OAA by explaining the advantages.

### 3. Formation of audit alliance & audit team:

The OAA consisted of multiple audit teams with members with considerable amounts of experience that were employees of food companies, primarily within the state of Oklahoma. OAA also included student members who were enrolled in a quality management and auditing course at Oklahoma State University. The author was a member of each team throughout the process and actively trained, monitored and participated in the OAA team's activities and audits.

An application was made available for each company to register for the OAA. All applications were reviewed and members were accepted based on a criteria. The criteria requirements are as follows:

- The company shall implement a GFSI benchmarked scheme as their food safety standards system; and,
- The members must be willing to be part of the OAA, should be full time. employees of the applicant company, and have at least 1 year experience, or should have completed at least one GFSI benchmarked system's certification audit and be able to understand the criteria.

Student participation was an integral part of the OAA process with the agenda of training the students and providing on-site experience on handling food safety and quality

systems. The eligibility criteria for the student included maintaining enrollment status as an undergraduate junior or higher with a major or minor in food science or food safety. The students were also trained in HACCP, internal auditing and other food safety GFSI benchmarked schemes and other aspects on which the industry participants were trained.

**Phase II – Project Implementation**

**4. Training of the audit team:**

All of the organizations that participated in this project were required to have at least one team member participate in the entire audit process. All the participants attended a one-day, mandatory, auditor training workshop. Employees were fully trained by the author with the help of the professional training staff at the Robert M Kerr Food and Agricultural Product Center (FAPC). Pre and post tests were conducted to evaluate the competency of training following the Kirkpatrick training evaluation Level 1 & Level 2 approaches. Auditing individuals were trained at FAPC and the following topics were covered:

- Confidentiality;

- Audit ethics and code of conduct;

- Audit scope;

- Understanding the FAPC FSQ criteria;

- Understanding the scoring guidelines on FAPC FSQ criteria;

- Setting up the audit timeline;

- Methods of audit findings and correction;

- Audit checklist preparation and report writing;

- Objective evidence collection; and,

- Opportunities for improvement (OFIs) identification classifications.

Upon completion of the training, a certificate of attendance was provided and the attending team members were considered qualified OAA auditors and members of the OAA. A makeup training and refresher training was available upon request of the participating members. An additional training session was provided for students and members who registered after first training.

## 5. Onsite audit process:

Relevant training was provided to the audit team before the audit by approved trainers. The audit teams were formed by the end of the training day with at least 2 members of OAA, a trained individual from FAPC and at least one student participant that was enrolled in the program. After the audit team was formed, the audit dates were scheduled and communicated. Every participant from a company that applied to be part of the OAA participated in the audit of a different company, along with at least 3 other auditors that included: a qualified food safety professional from FAPC; an employee of an Oklahoma food processing company; and, a student from Oklahoma State University. On-site audits were conducted over an approximately 2 day periods. During the 2 days of audit, the organizations were audited using FSQ criteria and the organization's GFSI scheme criteria. The auditors were expected to completely address the criteria through

different mechanisms including observation of documents, process monitoring, and personal interviews.

Addressing the OFIs by the audited companies:

Once the on-site audit was completed, the quality of the FSQS programs was evaluated based on the number of non-compliances (OFIs) identified by the auditors. A report was generated by the audit team based on the OFIs identified during the audit. Suggestions to address the OFIs were provided during the audit by the audit team members to the organization audited. A comprehensive final report containing observations made during the audit was compiled and submitted to the organization audited. Audit reports were submitted only after auditing all the participating organizations.

6. **Data collection and analysis:**

The data collected to test the effectiveness of the program were the responses to the survey questionnaire and competency testing of the auditing skills of the audit alliance members before training verses after the audit. It also included the results of a satisfaction analysis from a survey of the senior management of the participating companies. Relevant statistical analysis (mean, standard deviation, Mann-Whitney-Wilcoxon test) was performed based on the sample size of the companies, OAA members and students. The data gathered using the survey questionnaire was based on Kirkpatrick training evaluation method. In the next section, the Kirkpatrick method is discussed in detail.

## 7.  Testing the effectiveness of the methodology

Testing the effectiveness of the methodology was done throughout the process using the Kirkpatrick evaluation model. Effectiveness testing included-

a. Use of Kirkpatrick's method of evaluation of learning and training (Farjad, 2012).

   i. Helps to determine if the implemented program is able to deliver the intended information.

   ii. Helps to evaluate if the training program has been able to deliver the goals and objectives in terms of cost incurred and benefits achieved.

   iii. Analyzes parameters such as reaction, learning, behavior and some aspects of results with measurement indicators to each parameter.

b. A survey questionnaire-based comparison of knowledge about GFSI auditing skills of audit alliance members before training verses post training.

All the questionnaire responses were collected as per the following schedule. The pre training questionnaire response was collected before the internal auditor training. The post training response was collected after the training. Program conclusion survey data were collected after the completion of the program.

Table 3.1 shows a list of the training tools, programs and questionnaires developed for the program.

Table 3.1 Complete list of training tools, programs and questionnaires development for the project.

| Serial Number | Program tool | Purpose |
|---|---|---|
| 1 | Training material (Audit approach, auditor ethics etc.) | Internal auditor training |
| 2 | FSQ criteria | OAA audit |
| 3 | Scoring kit for FSQ criteria | OAA Audit |
| 4 | Pre-Training Questionnaire | Kirkpatrick Analysis Level -1 |
| 5 | Post –Training Questionnaire | Kirkpatrick Analysis Level -2/3 |
| 6 | Program Conclusion survey | Kirkpatrick Analysis Level -2/3 |

**IRB approval:**

The Institutional Review Board (IRB) is a committee established to review and approve research involving human subjects at Oklahoma State University. IRB approval was required to collect the data from participants. Data was collected only after the IRB approval. Documents related to the IRB approval are provided in Appendix E.

CHAPTER IV


RESULTS AND CONCLUSION

This chapter covers the results and conclusions of the projects. As per the objectives

mentioned in the Chapter I, the main purpose of the project was to develop, promote and

implement an Oklahoma Audit Alliance (OAA) and analyze its effectiveness using a

survey-based analysis modeled after the Kirkpatrick method (Levels 1, 2 & 3)

The following tasks were successfully completed.

1.  Based on the response to the survey questionnaire, the idea of best practices

    sharing among food processors in Oklahoma was initiated. Extensive outreach

    was performed and 7 organizations from Oklahoma participated in the

    program. Although it was hard to measure "promoting the idea" of best

    practice sharing, multiple organizations showed significant interest, and

    invested time and money in the program. The interest and investment reflects

    on the success of the program, and its intention to promote the best practice

    sharing by knowledge exchange sessions and audits. Once the program was

    developed, it was presented to Robert M. Ker Food and Agricultural Product

    Center's Industry Advisory Committee (IAC) members for the feedback and

    improvements were made based on the suggestions received.

2. An FSQ audit criterion was developed and GFSI schemes were adopted as primary tools to be used in the process to address critical areas of business relevant to food safety, product quality, and continuous improvement. This new criteria that was developed by integrating food safety concepts with MBNQA core values helped participants make a thorough analysis of their organizational food safety program at a deeper level.

3. Multiple audit teams were formed and were sent to participating organizations to observe and document successful strategies and continuous improvement methods implemented by the participating organizations. Observation reports were developed by each audit team and submitted to the organizations.

4. Audit teams assessed existing GFSI Food Safety and Quality Systems (FSQS) such as SQF, BRC and PRIMUS and internal audit observation reports were provided. The audit reports included both observations and non-conformities.

5. The effectiveness of the OAA methodology on the food industry (survey analysis). As discussed in previous chapters, the Kirkpatrick model of evaluation was used. Three different questionnaires were used for this process and the results obtained are shown below.

Kirkpatrick evaluation results:

The following histograms show the responses to the questionnaire for 3 levels of training. The responses were collected from the participants before and after the training and after the conclusion of the program. Each histogram represents specific questions and shows mean, standard deviation and range of scores.
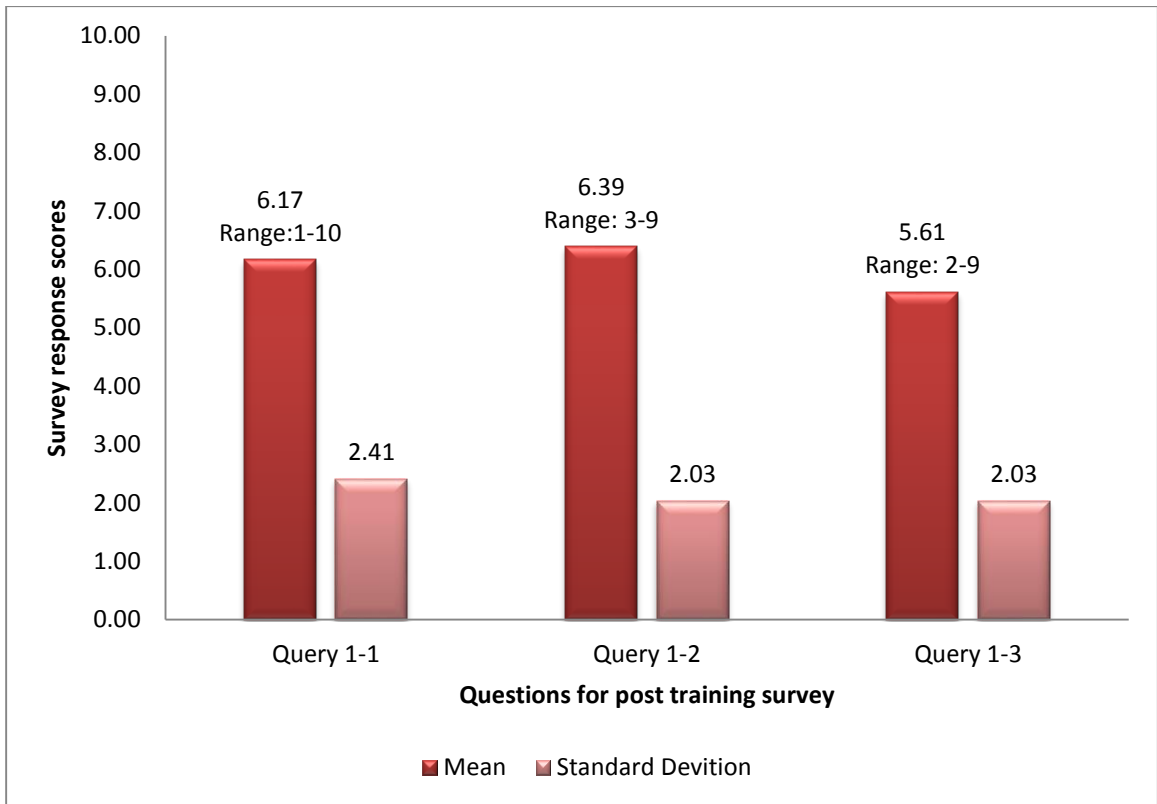
Survey response results:



Fig 4.1 Histogram showing mean, standard deviation and range of the response scores received for the pre-training questionnaire shown below.

Query 1-1: I am aware of the processes used as the organizational continuous improvement programs to enhance the effectiveness of food safety and quality programs within my organization.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Not at all)                                        (10= A great deal)

Query 1-2: On a scale 1-10, I would rate my current knowledge level on food safety, quality programs

1-------2-------3-------4------5------6------7------8------9------10

(1 – Very low)                                             (10- Very high)

Query 1-3: On a scale 1-10, I would rate my current knowledge level on using continuous improvement programs to enhance the food safety, and quality programs.

1-------2-------3-------4------5------6------7------8------9------10

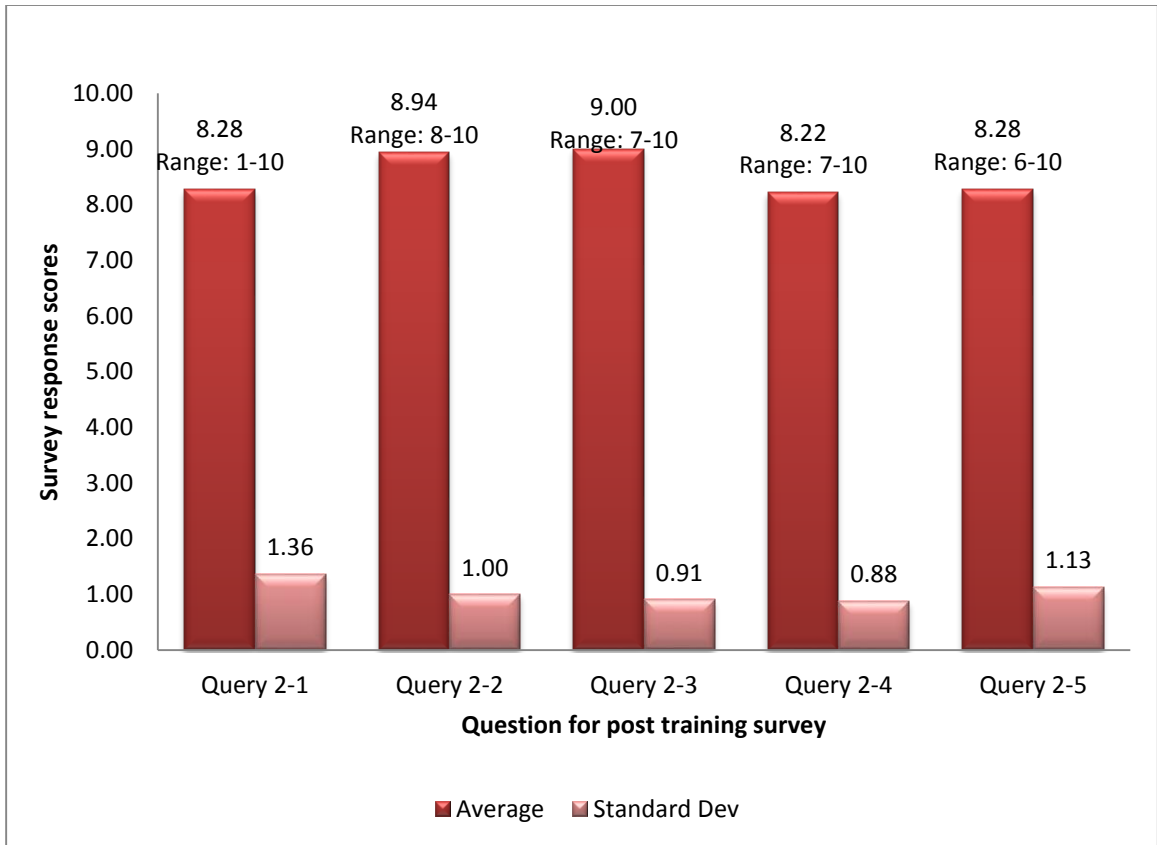(1 – Very low)                                             (10- Very high)

Fig 4.2 Histogram showing mean, standard deviation and range of the response scores received for the post-training questionnaire shown below.

Query 2-1: I have enjoyed the training throughout the process?

1-------2-------3-------4------5------6------7------8------9------10

    (1  = Strongly disagree)                            (10= Strongly agree)

Query 2-2: I would consider the training relevant to me?

1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)                            (10= Strongly agree)

Query 2-3: I would consider participating in this program a good use of my time?

1-------2-------3-------4------5------6------7------8------9------10

     (1   = Strongly disagree)                      (10= Strongly agree)

Query 2-4: I like the program layout, approach, the style, and timing?

1-------2-------3-------4------5------6------7------8------9------10

     (1   = Strongly disagree)                      (10= Strongly agree)

Query 2-5: I am satisfied by the Level of participation of myself.

1-------2-------3-------4------5------6------7------8------9------10

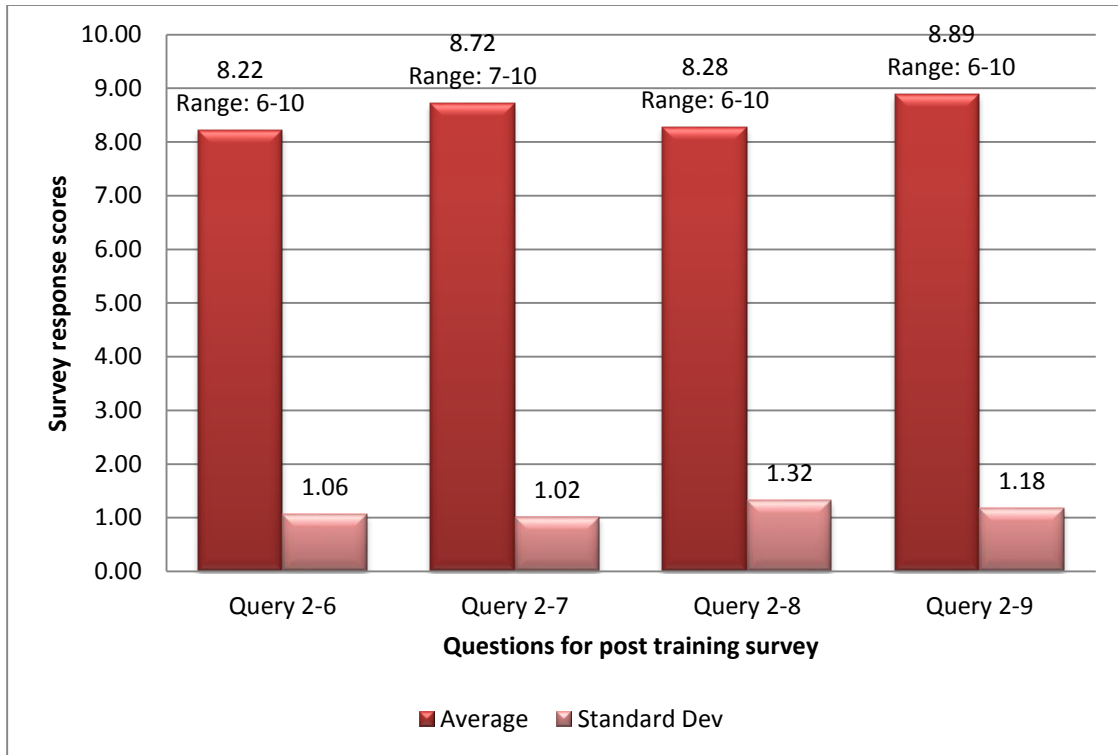     (1 = Strongly disagree)                      (10= Strongly agree)

Fig: 4.3 Histogram showing mean, standard deviation and range of the response scores received for the post-training questionnaire shown below.

Query 2-6:I am satisfied by the level of effort required to make the most of the learning.

1-------2-------3-------4------5------6------7------8------9------10

(1= Strongly disagree)                          (10= Strongly agree)

Query 2-7: I can recognize practicality of this program content and approach and potential for applying the learning.

1-------2-------3-------4------5------6------7------8------9------10

(1  = Strongly disagree)                          (10= Strongly agree)

Query 2-8: Was this training/program better than what you expected, worse than what you expected, or about what you expected?

1-------2-------3-------4------5------6------7------8------9------10

(1= worse than expected)                              (10= exceeded expectation)

Query 2-9: The information I have learned during this program is useful?

1-------2-------3-------4------5------6------7------8------9------10

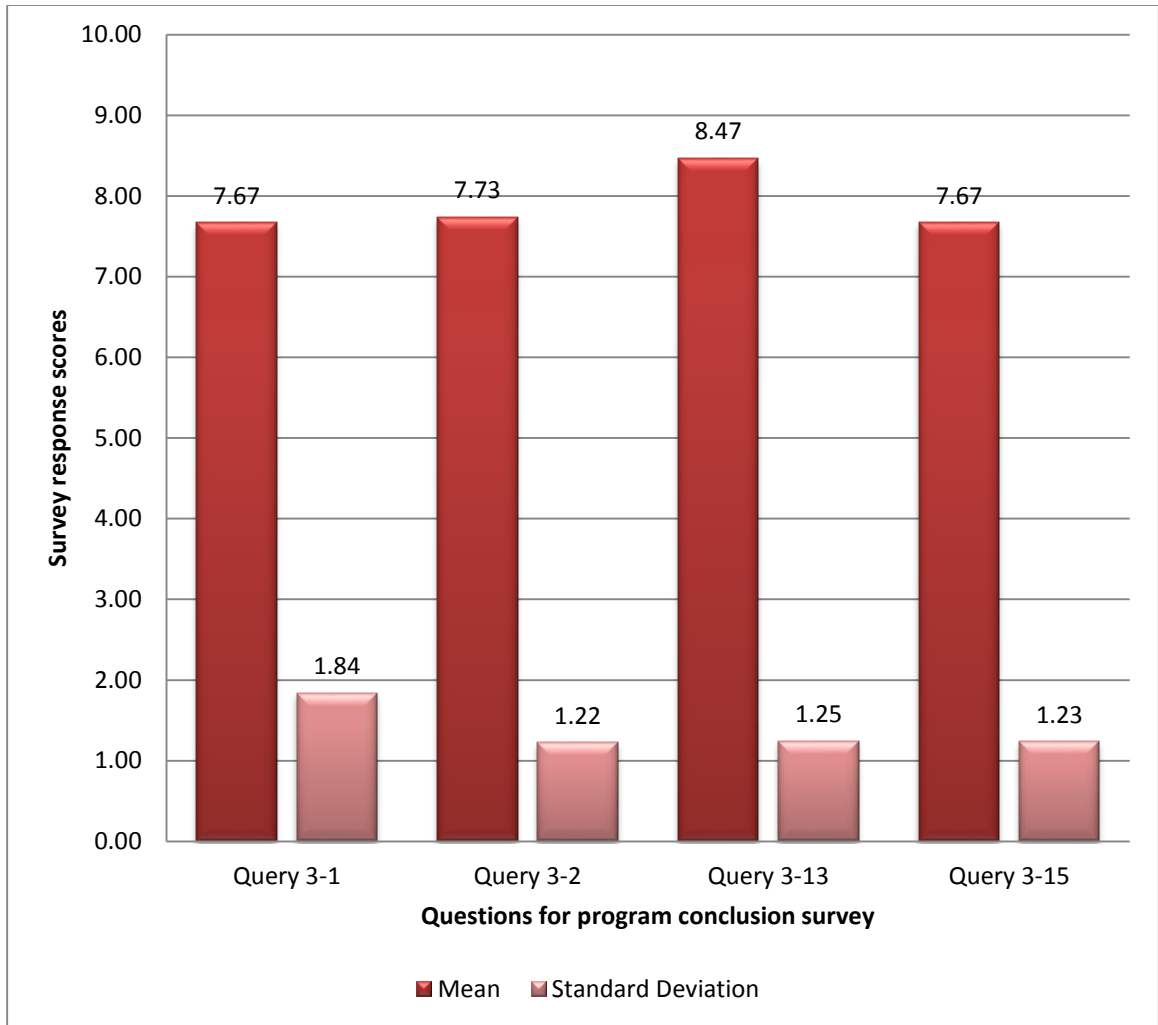(1 = Strongly disagree)                              (10= Strongly agree)

Fig 4.4 Histogram showing mean, standard deviation and range of the response scores received for the program conclusion questionnaire shown below.

Query 3-1: I am aware of the processes used as the organizational continuous improvement programs to enhance the effectiveness of food safety and quality programs within organization.

1-------2-------3-------4------5------6------7------8------9------10

(1   = Not at all)                                    (10= A great deal)

Query 3-2: My knowledge/skills have improved because of the participation in the event?

1-------2-------3-------4------5------6------7------8------9------10

(1　= Not at all)                                    (10= A great deal)

Query 3-13: This program helped me recognize "continuous improvement" as a

significant aspect of the food safety and quality management systems

1-------2-------3-------4------5------6------7------8------9------10

(1　= Strongly disagree)                             (10= strongly agree

Query 3-15: On a scale 1-10, I would rate my current knowledge level on food safety,

quality and continuous improvement programs (Did this program help you?)

1-------2-------3-------4------5------6------7------8------9------10

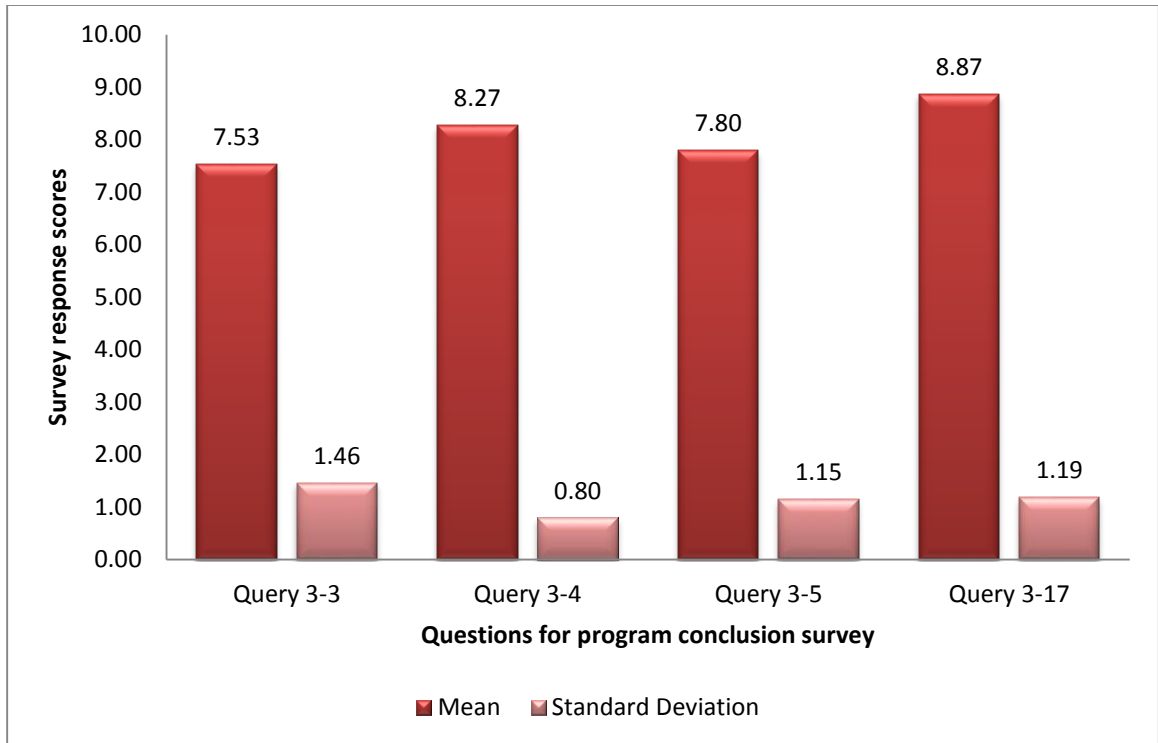(1- Very low)                                       (10- Very high)

Fig 4.5 Histogram showing mean, standard deviation and range of the response scores received for the program conclusion questionnaire shown below.

Query 3-3: Was this program better than what you expected, worse than what you expected, or about what you expected?

1-------2-------3-------4------5------6------7------8------9------10

(1= Worse than expected)                              (10= Exceeded expectation)

Query 3-4: How useful was the information you have learned by participating in this program?

1-------2-------3-------4------5------6------7------8------9------10

(1  = Not at all)                              (10= A great deal)

67

Query 3-5: This program helped me establish certain objectives within organization to accomplish future needs of food safety and quality aspects.

1-------2-------3-------4------5------6------7------8------9------10

(1   = Not at all agree)                                    (10= strongly agree)

Query 3-17: Overall, were you satisfied with this program?

1-------2-------3-------4------5------6------7------8------9------10

(1 = Extremely satisfied)                          (10= Extremely dissatisfied)
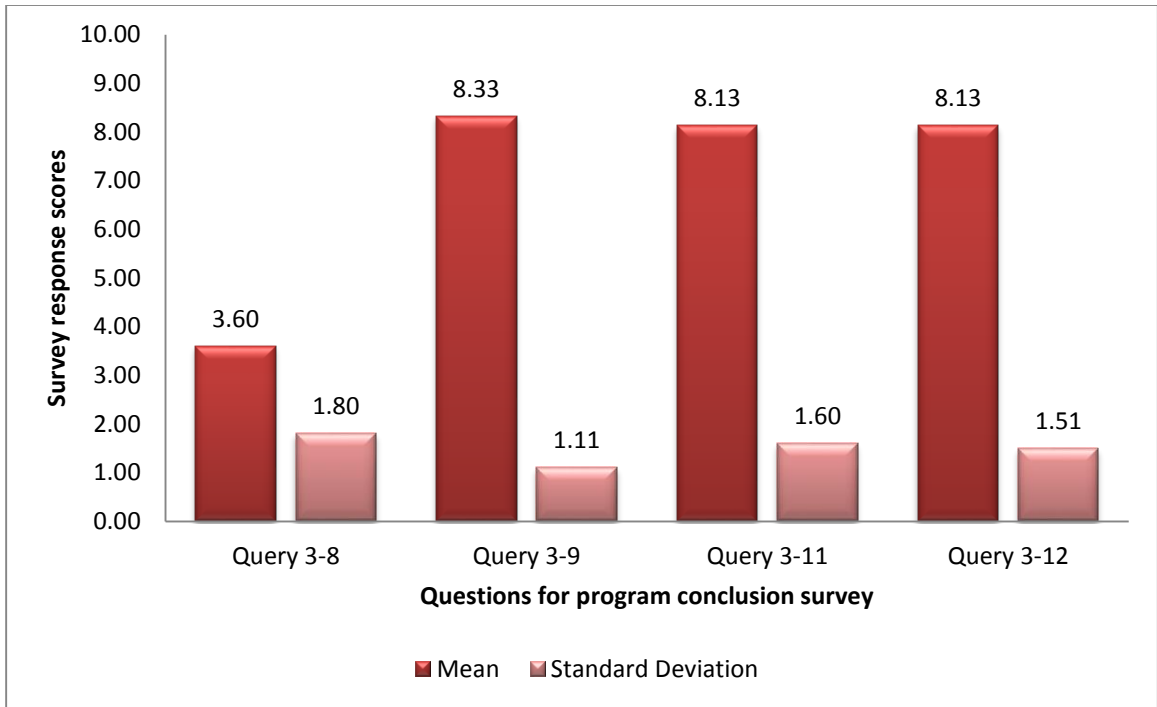
Fig 4.6 Histogram showing mean, standard deviation and range of the response scores received for the program conclusion questionnaire shown below.

Query 3-8: I am already aware of most of the information provided through this program. (This program did not help me a lot)

1-------2-------3-------4------5------6------7------8------9------10

(1  = Strongly disagree)                                        (10= strongly agree)

Query 3-9: During the course of this program, I have learned what I have intended to learn?

1-------2-------3-------4------5------6------7------8------9------10

(1  = Strongly disagree)                                        (10= strongly agree)

69

Query 3-11: I will be able to apply on the job what I learned by participating in this program.

1-------2-------3-------4------5------6------7------8------9------10

(1   = Strongly disagree)                                    (10= strongly agree)

Query 3-12: I do not anticipate any barriers to applying what I learned by participating in this program. (Level 3)

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                                      (10= strongly agree)
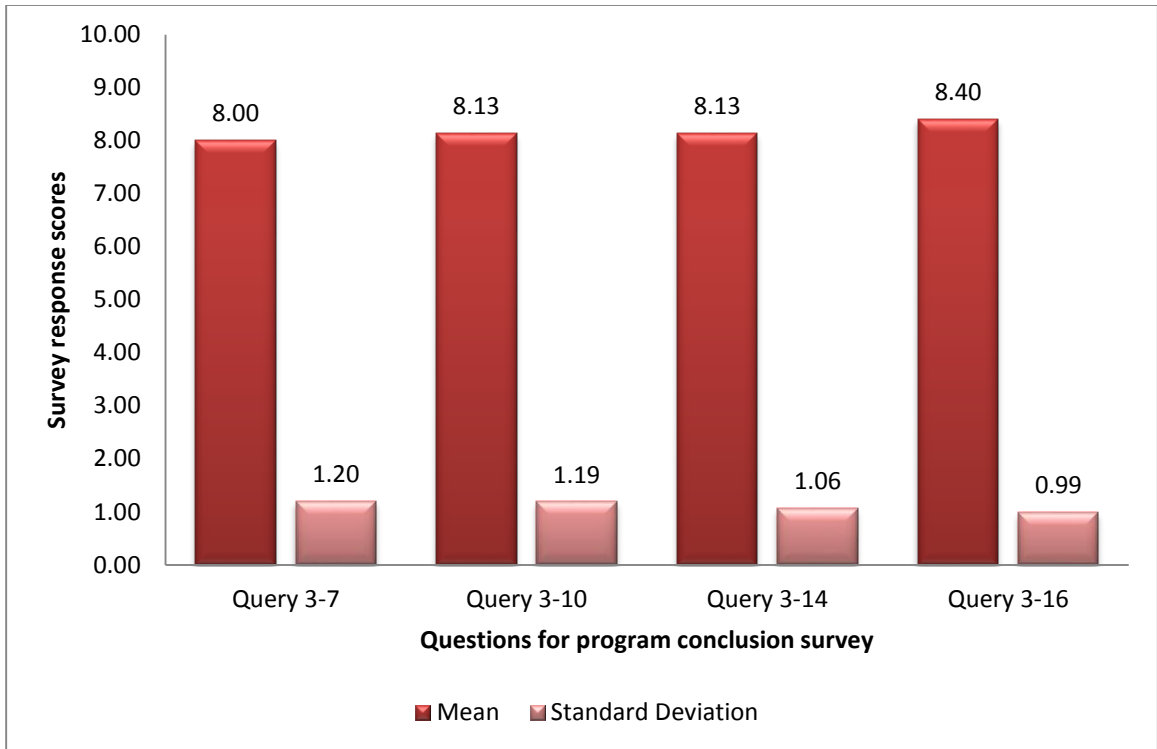
Fig: 4.7Histogram showing mean, standard deviation and range of the response scores

received for the program conclusion questionnaire shown below.

Query 3-7: Participating in Oklahoma Audit Alliance program has improved my

commitment towards food safety and quality systems in the organization.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Not at all agree)                                (10= strongly agree)

Query 3-10: I am clear about what is expected of me as a result of going through this

training.

1-------2-------3-------4------5------6------7------8------9------10

(1  = Strongly disagree)                              (10= strongly agree)

71

Query 14: Participating in this program has helped me take a different approach in

performing certain jobs that are related to food safety and quality

1-------2-------3-------4------5------6------7------8------9------10

(1= Strongly disagree)                                        (10= strongly agree)

Query 3-16: I anticipate that I will eventually see positive results as a result of my efforts.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                                        (10= strongly agree)
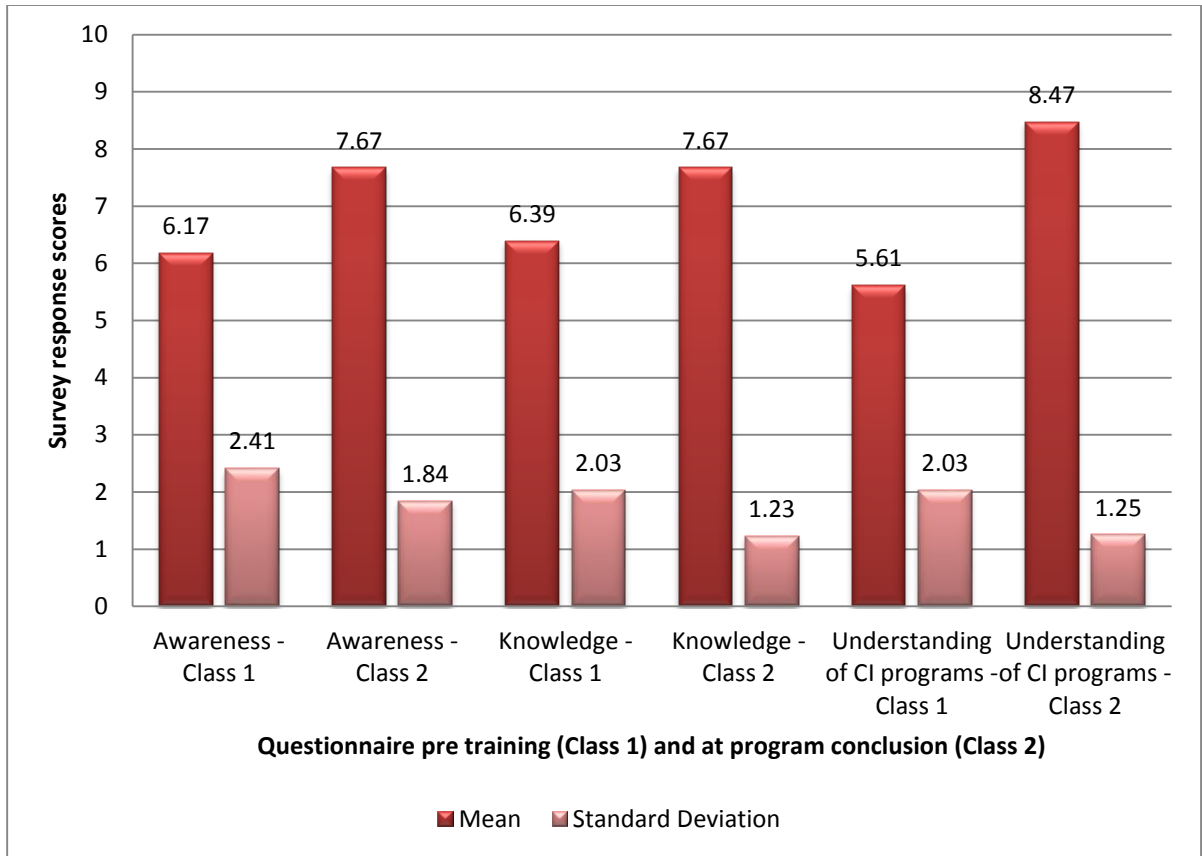
Fig 4.8: Histogram showing the comparison of response scores pre training vs program conclusion. Class 2 response scores showed that there was increased awareness, knowledge and understanding of food safety, quality and continuous improvement programs.

**Non parametric statistical testing results:**

Table 4.1 shows the statistical analysis using the Mann-Whitney-Wilcoxon non parametric test for increase in awareness of food safety and quality concepts due to participation in the OAA program.

Table 4.1 Mean, Standard Deviation, Median, Range, P-Value (Right sided), P-value (two-sided) for the class 1 (Pre training) and Class 2 (Program conclusion survey) of the trained participants.

| Question | Class | N | Mean(SD) | Median | Range | P-value, (Right-sided) |
|---|---|---|---|---|---|---|
| Awareness | 1 | 18 | 6.2 (2.4) | 7.0 | 1.0-10.0 | 0.024 |
| | 2 | 15 | 7.7 (1.8) | 8.0 | 3.0-10.0 | |
| Knowledge levels | 1 | 18 | 6.4 (2.0) | 7.0 | 3.0-9.0 | 0.046 |
| | 2 | 15 | 7.7 (1.3) | 8.0 | 6.0-10.0 | |
| Understanding importance of continuous improvement programs on food safety | 1 | 18 | 5.6 (2.0) | 6.0 | 2.0-9.0 | 0.00003 |
| | 2 | 15 | 8.4 (1.2) | 8.0 | 7.0-10.0 | |

The statistical analysis was performed to understand increased knowledge levels and awareness over concepts of food safety and quality, and understanding the importance of continuous improvement programs on food safety.

Addressing the research hypothesis, the following conclusions were made.

Hypothesis 1:

Null hypothesis (H$_o$): There was no increase in knowledge about food safety and product quality by program participants.

Alternate hypothesis (H$_o$): There was an increase in knowledge about food safety and product quality by program participants.

Mann Whitney – Wilcoxon test showed that the right-sided test P value was 0.046. As the P-value $< 0.05$, the null hypothesis was rejected and the conclusion was: There was a significant difference in participants' knowledge about food safety and product quality.

Hypothesis 2:

Null hypothesis (H$_o$): There was no increase in awareness about food safety, product quality of the program participants.

Alternate hypothesis (H$_o$): There was an increase in awareness about food safety and product quality by program participants.

Mann-Whitney-Wilcoxon test showed that the right-sided test P value was 0.024. As the P-value $< 0.05$, the null hypothesis was rejected and the conclusion was: There was a significant difference in participants' awareness about food safety and product quality.

Hypothesis 3:

Null Hypothesis (H$_o$): There was no increase in understanding about continuous improvement by program participants.

Alternate hypothesis ($H_o$): There was an increase in understanding the importance of continuous improvement with regard to food safety and product quality.

Mann-Whitney-Wilcoxon test showed that the right-sided test P value was 0.00003. As the P-value $< 0.05$, the null hypothesis was rejected and the conclusion was: There was a significant difference in participants' understanding the importance of continuous improvement with regard to food safety and product quality.

**Conclusion:**

The OAA program was implemented in the state of Oklahoma over a period of 6 months. A total of 18 organizations were contacted regarding the project and 7 organizations participated. The most probable reason behind not having more organizations participate in OAA was the newness of the program. Lack of similar programs in Oklahoma was another reason. All the participants were thoroughly trained on food safety aspects and FSQ criteria. Audits were conducted and findings were reported after completing all the audits. The program was new and therefore the sample size was relatively small. Other reasons for the small sample size were the lack of a strong position of programs that were similar to OAA within the state, and the fact that the audit alliance program was limited to the state of Oklahoma. The sample size for the survey responses (number of participants) was $n \leq 19$ where n is different in each stage due to the varying number of participants. The number of participants varied due to changing jobs within the company or moving to different organization during the program cycle.

Kirkpatrick level 1 evaluation responses have shown that the participants reacted well about the program and what they learned through the training process. Figures 4.2 and 4.3 have shown that all of the scores from the post training survey (reaction) were above 7. Participants also responded with high scores with an average of over 7 (scale 1-10), for the learning aspects of Kirkpatrick Level 2 & 3 questions that are listed in Questionnaire 2 and Questionnaire 3. The relevant histograms are shown above in Figures 4.4 through 4.7. Based on Figures 4.1 through 4.7, it was evident that participants were introduced to a new approach (FSQ criteria) to assess their FSQMS by their involvement in OAA

Figure 4.8 shows the comparisons between awareness, knowledge levels and understanding of aspects relevant to food safety, quality and continuous improvement programs. There was an increase in average response of scores between class 1 (pre training) and class 2 (program conclusion). A decrease in standard deviation scores was also observed in class 1 and class 2 response scores. Although FSQ criteria were new to the group of participants, increased knowledge was reported. Every participant reported that they learned at least 1 to 5 new aspects that can be considered "ideas" that may be implemented within their organization. Some participants reported that more than 5 new aspects were learned. This was evidence that there had been best practice sharing, although it was not clear how well the learned aspects would reflect the organizational results which can be determined by Kirkpatrick Level -4 evaluation. Based on the inferences drawn from the Mann-Whitney-Wilcoxon test from Table 4.1, it was evident that there was a significant difference in participants' learning in the aspects of

knowledge, awareness and understanding of food safety, quality and continuous

improvement programs before and after participation in the OAA program.

**Limitations and future implications:**

Multiple limitations were observed throughout the project implementation

process.

- Sample size was low. (n≤19). As discussed earlier, this was probably due to the

  program being new and concerns regarding confidentiality issues. Also, the

  project was geographically restricted to Oklahoma.

- A number of participants dropped out due to jobs changes, not related to the

  study.

- Although it was not measured, it was a point of consideration that participants

  might not have a full commitment to the new criteria which was not mandated by

  any customer or governing body. Reactions to food safety and quality criteria

  were very favorable and high level of commitment was observed.

- Kirkpatrick evaluation Level 4, which focuses on direct results of training, was

  not conducted at this time. Conducting Level -4 evaluation might provide more

  information on how learning was implemented and results obtained.

- Measurement of food safety culture using various tools might help understand the

  improvement in organizational food safety culture and organizational behavior

  towards food safety, product quality and continuous improvement aspects.

- Most important aspect of the MBNQA process is the initial assessment conducted

  using the 50 page application submitted by participating organizations. Having

the initial review process included in OAA program might help participants gain more insight about the organization being audited before the site visit.

In conclusion, OAA was a successful idea that helped initiate best practice sharing between food companies. Aggressive participation by overcoming confidentiality aspects helped food safety professionals and organizations improve their knowledge, awareness and understanding of food safety, quality and continuous improvement by sharing information. This could help identify cost-effective methods and also help elevate the overall food safety of the organizations and the community.

CHAPTER V

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**Appendix A**

**FSQ Criteria**

About the criteria:

The Oklahoma Audit Alliance – Robert M. Kerr Food & Agricultural Products Center Food Safety Quality criteria for the participating organizations is focused to help strengthen goals, performance and toward building a strong, cost effective and competitive food safety and quality management systems.

Criteria for Food Safety Management Systems:

The criteria provides guidance for the evaluation of certain food safety and quality parameters, along with continuous improvement strategy practices to achieve excellent standards with regard to food safety and quality. This criteria also focuses on strategic quality improvement practices and measures organizational performance through quality and safety standards on common grounds.

This criterion involves core values focusing on food safety, quality and continuous improvement aspects of the following areas relevant to business:

- Strategic planning and management commitment

- Continuous improvement methods

- Knowledge management

- Customer management

- Employee management

Scoring system:

The strength of an organization's prevailing systems are evaluated using a scoring system. The scoring system helps identify the most effective methods and practices.

The table in the next page shows the scoring system used for the audit using FSQ criteria.

| Scoring scale (0-10) | Scoring guidelines | Level Rating |
|---|---|---|
| **Score – 0** | Organization does not have any program, policy, process or evidence to meet the criteria requirements. | NA |
| **Score – 1-3** | Organization has very few programs, policies and processes to meet the criteria requirements at the beginner level with few evidences of implementation (Beginner level). | Beginner Level |
| **Score – 4-5** | Organization has the majority of programs, policies and processes to meet the criteria requirements with evidence of implementation (Intermediate level). | Intermediate Level |
| **Score – 6-8** | Organization has all of the required programs, policies and processes to meet the criteria requirements with all clear evidence of implementation including some verification and validation (Advanced level). | Advance Level |
| **Score 9-10** | Organization has all of the programs, policies, processes and evidences that it has met the criteria requirements and that they have been effectively implemented, verified, and validated (Expert level). | Expert Level |

Table A.1: Scoring system and score guidelines for FAPC FSQ criteria.

FSQ Criteria

Strategic planning and management commitment:

1. What are the organization's food safety and product quality goals and objectives? Is a timeline established to address the organizational goals and objectives?

2. What is the approach of senior leaders in promoting food safety and quality within the organization?

3. How do senior leaders reflect their commitment towards promoting food safety culture, legal and ethical behavior within multiple levels of organization?

4. How does the organization plan, develop and establish a strategy to have a reliable food safety and quality system in place?

5. How do senior leaders ensure that the appropriate financial commitment and investments are made in order to maintain the safety and quality of food products produced?

6. What are the organization's short and long term goals with regard to the improvement of food safety and quality?

7. How does the organization consider relevant food safety information about processing methods when establishing sustainable food safety strategies?

8. How do you anticipate public concerns with your current and future products and operations?

9. How do you address any adverse impacts of your products and operations on society?

10. What is the decision-making strategy regarding food safety issues and concerns?

11. How does the organization ensure that transparency is maintained in operations and decisions that impact food safety?

12. What is the organization's level of commitment toward research and development on food safety and quality aspects of their products?

13. How does the organization design, manage, and improve products, services and work processes to reduce food safety and quality issues?

14. What is the evidence for a leadership driver food safety and quality culture in the organization?

15. How does the organization review the standard of food safety culture within the organization? How do they include the aspects of food safety and quality culture in strategic planning process?

**Continuous improvement methods:**

1. What are the organizational commitments toward continuous improvement and its initiatives with regard to product safety and quality?

2. How are the continuous improvement initiatives selected and prioritized for implementation?

3. What are the processes and methods used to evaluate the food safety, quality and continuous improvement programs?

4. How are performance measures aligned, tracked and utilized to support system level decision-making, continuous improvement and innovation in the organization?

5. What are the organization's approach and deployment methods of data and its utilization to support and drive innovation regarding food safety and quality aspects?

6. What is your current process for gathering and evaluating comparative data to drive innovation?

7. What are the organization's innovative practices in deployment of opportunities for improvements in food safety, product quality, daily operations and employee management?

8. How is comparative data used to make decisions through the planning and implementation cycles across entities and throughout different levels in the organization?

9. How does the organization gather and utilize data related to food safety and quality through social media for learning?

10. What market data resources are used outside of customer feedback? How is this information gathered and analyzed?

11. What is the organization's approach to review and assess competitive performance within and outside the organization?

12. How is internal, external and third-party audit information analyzed, reviewed and implemented within the organization?

13. What is the organization's approach and process for involving suppliers, partners and collaborators to ensure organizational alignment and address various levels regarding food safety, product quality and continuous improvement strategies?

14. What is the organization's approach to design, implement and improve key work processes to deliver products that achieve customer value and organizational success and sustainability?

15. How does the organization measure cost of food safety and quality incidents (e.g: preventive investment costs verses incidents costs)?

16. What are the organization's measurement focuses? What methods are employed? What practices are implemented to review the research, design and management of programs developed for prevention and continuous improvement of food safety and quality management systems?

Knowledge Management:

1. What are the basic qualifications of the food safety and quality team members at the different organizational levels?

2. How does the organization stay up-to-date with knowledge about food safety quality in food processing and handling?

3. How is the effectiveness of training reviewed in order to ensure all employees are knowledgeable in the areas they are trained?

4. What data is collected and reviewed to determine the knowledge levels and training requirements of current and future employees? How does the organization make data-driven decisions related to training requirements and effectiveness of the training approach?

5. How does the organization's food safety and quality team stay up-to-date on emerging food safety issues related to physical, chemical, biological and allergenic materials? (e.g.: Emerging pathogenic concerns, microbiological trends and quality concerns)

Customer Management:

1. How does the organization determine customer engagement? How do these determination methods differ among customer groups? (Note: Applicable only if there is more than one customer)

2. What are the primary channels to improve customer and supplier relationship management?

3. How does the organization listen to and capture the voice of customers? How do listening methods vary for different customers?

4. What is the organization's approach to determine customer satisfaction and dissatisfaction regarding safety and quality of products and processes?

5. How does the organization manage customer complaints? How does the existing customer complaint management process ensure that complaints are resolved promptly and effectively?

6. How does customer complaint management processes enable the organization to gain customer confidence and enhance their satisfaction and engagement?

7. How does the organization consider food safety and quality incidents and their level of concern? How are incidents differentiated?

8. What is the basis and approach towards organizational emergency and business continuity plan? How does the organization ensure that their approach is effective?

Employee Management:

1. What is the organization's approach in determining capacity and capability of the workforce?

2. How does the organization ensure that employees are capable and knowledgeable at different levels to handle the food safety, product quality and continuous improvement projects?

3. How does the organization identify barriers and address those regarding innovative ideas and communication of ideas to promote best practices?

4. How do the lines of communication work in the organization? How does the organization promote interdepartmental and two-way communication about food safety and quality?

5. How are new ideas captured and reviewed? How are those ideas prioritized in the organization within different levels of workforce and different departments? How are the ideas implemented? How is the effectiveness of ideas evaluated?

6. How does the organization ensure ethical behavior compliance, incident management and ethical training? How is the effectiveness of training reviewed?

**Appendix B:**

Pre Training Questionnaire – I

- How long have you been working with food safety and quality systems in the food industry?

  a. No experience – I am a student

  b. 1-3 years

  c. 3-6 years

  d. 6-10 years

  e. Over 10 years

- Highest level of education

  a. High School

  b. Some college

  c. Bachelor's Degree(s)

  d. Master's Degree(s)

  e. Doctoral Degree

- Total number of employees in the organization I am currently employed with

  a. 0-50

  b. 51-100

  c. 101-250

  d. 251-500

- I am aware of the processes used as the organizational continuous improvement programs to enhance the effectiveness of food safety and quality programs within my organization.

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Not at all)                                                                 (10= A great deal)

- On a scale 1-10, I would rate my current knowledge level on food safety, quality programs

    1-------2-------3-------4------5------6------7------8------9------10

- On a scale 1-10, I would rate my current knowledge level on using continuous improvement programs to enhance the food safety, and quality programs.

    1-------2-------3-------4------5------6------7------8------9------10

## Appendix C:

Post Training Survey - Questionnaire – 2

1. I have enjoyed the training throughout the process?

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)               (10= Strongly agree)

2. I would consider the training relevant to me?

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)                     (10= Strongly agree)

3. I would consider participating in this program a good use of my time?

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)                     (10= Strongly agree)

4. I like the program layout, approach, the style, and timing?

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)                     (10= Strongly agree)

5. I am satisfied by the Level of participation of myself.

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)                     (10= Strongly agree)

6. I am satisfied by the level of effort required to make the most of the learning.

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Strongly disagree)               (10= Strongly agree)

7. I can recognize practicality of this program content and approach and potential for

    applying the learning.

    1-------2-------3-------4------5------6------7------8------9------10

(2  = Strongly disagree)                    (10= Strongly agree)

8.   Was this training/program better than what you expected, worse than what you expected,

or about what you expected?

1-------2-------3-------4------5------6------7------8------9------10

(1  = worse than expected)          (10= exceeded expectation)

9.  The information I have learned during this program is useful?

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                              (10= Strongly agree)

**Appendix D**

**Questionnaire-3 – Program conclusion survey**

- How long have you been working with food safety and quality systems in the food industry?

    a. No experience

    b. 1-3 years

    c. 3-6 years

    d. 6-10 years

    e. Over 10 years

- Highest level of education

    a. High School

    b. Associate Degree

    c. Bachelor's Degree(s)

    d. Master's Degree(s)

    e. Doctoral Degree

- Total number of employees in the organization I am currently employed with

    a. 0-50

    b. 51-100

    c. 101-250

    d. 251-500

    e. 501-1,000

    f. Over 1,000

    g. I am a student

- I am aware of the processes used as the organizational continuous improvement programs to enhance the effectiveness of food safety and quality programs within organization.

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Not at all)                                      (10= A great deal)

- My knowledge/skills have improved because of the participation in the event?

    1-------2-------3-------4------5------6------7------8------9------10

    (2  = Not at all)                                     (10= A great deal)

- Was this program better than what you expected, worse than what you expected, or about what you expected?

    1-------2-------3-------4------5------6------7------8------9------10

    (1  = worse than expected)                  (10= exceeded expectation)

- How useful was the information you have learned by participating in this program?

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Not at all)                                      (10= A great deal)

- This program helped me establish certain objectives within organization to accomplish future needs of food safety and quality aspects.

    1-------2-------3-------4------5------6------7------8------9------10

    (1 = Not at all agree)                               (10= strongly agree)

- Total number(approximately) of new concepts/ideas I have learned through this program that could help make my food safety and quality system programs stronger

    a. None

    b. 1-5

c.  5-10

d.  10-20

e.  Over 20

- Participating in Oklahoma Audit Alliance program has improved my commitment towards food safety and quality systems in the organization.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Not at all agree)                              (10= strongly agree)

- I am already aware of most of the information provided through this program. (this program did not help me a lot)

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                              (10= strongly agree)

- During the course of this program, I have learned what I have intended to learn?

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                              (10= strongly agree)

- I am clear about what is expected of me as a result of going through this training.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                              (10= strongly agree)

- I will be able to apply on the job what I learned by participating in this program.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                              (10= strongly agree)

- I do not anticipate any barriers to applying what I learned by participating in this program. (L3)

1-------2-------3-------4------5------6------7------8------9------10

- This program helped my recognize "continuous improvement" as a significant aspect of the food safety and quality management systems

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                    (10= strongly agree)

- Participating in this program has helped me take a different approach in performing certain jobs that are related to food safety and quality

1-------2-------3-------4------5------6------7------8------9------10

(1= Strongly disagree)                    (10= strongly agree)

- On a scale 1-10, I would rate my current knowledge level on food safety, quality and continuous improvement programs (Did this program help you?)

1-------2-------3-------4------5------6------7------8------9------10

- I anticipate that I will eventually see positive results as a result of my efforts.

1-------2-------3-------4------5------6------7------8------9------10

(1 = Strongly disagree)                    (10= strongly agree)

- Overall, were you satisfied with this program?

1-------2-------3-------4------5------6------7------8------9------10

(1 = Extremely dissatisfied)                    (10= Extremely satisfied)

# Appendix E

# IRB Approval form

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### Oklahoma State University Institutional Review Board

| | |
|---|---|
| Date: | Thursday, March 19, 2015 |
| IRB Application No | AG1513 |
| Proposal Title: | Determining effectiveness of Oklahoma Audit Alliance program |

| | |
|---|---|
| Reviewed and Processed as: | Exempt |

**Status Recommended by Reviewer(s): Approved    Protocol Expires:    3/18/2018**

Principal
Investigator(s):

| | |
|---|---|
| Raghavendra Rao Kakarala | Tim Bowser |
| 126 FAPC | 124 FAPC |
| Stillwater, OK 74078 | Stillwater, OK 74078 |

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The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Hugh Crethar, Chair
Institutional Review Board

## Appendix F

## Article - I

Development and implementation process of an Audit Alliance to promote sharing of successful food safety, quality and continuous improvement strategies

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Abstract: Third party audits, regulatory inspections and customer audits encourage food safety representatives in food processing sector to meet regulatory and customer requirements. Although these aspects have been standardized in food industry, there is a need for tools to empower the food sector in diagnosing and improving their food safety and quality systems by promoting best practice sharing. With the intension of improving knowledge and awareness of food safety and quality practices, enhancing the knowledge and understanding on continuous improvement programs with regard to food safety and quality, Audit Alliance (AA) was formed. The underlying agenda of the audit alliance was to promote best practice sharing with in food industry. Audit Alliance consists of participants from food companies, students, and other food safety professional from Oklahoma. Appropriate training was provided to the audit alliance members along with the necessary tools to participation organizations and conduct food safety, product quality and continuous improvement focused audits. Audit Alliance was a successful idea that helped initiate best practice sharing between food companies. Aggressive participation by overcoming confidentiality aspects help food safety professionals and the participating organizations to improve their knowledge, awareness and understanding of food safety, quality and continuous improvement aspects by sharing the information.

Introduction:

Food safety is neither simple nor very complex as it sounds. It is the science that deals with making the food safe to consume by preventing food borne pathogens from entering the food. Growth of food borne pathogens occur in different stages of food processing from farm to fork such as production in farms, processing, packaging, shipping, storage, distribution, retail and consumption. Food borne pathogens in food is a growing global concern, not only because of public health concerns and risks involved, but also because of the economic impact to the manufacturers which reflects on the economy. These issues are influencing the evolution of food safety requirements in the food processing industry. Awareness about food product safety within food industry has improved in recent years due to a number of high profile food recalls (Chan & Lai, 2009; Kumar & Budin, 2006;Roth, Tsay, Pullman,& Gray, 2008; Warriner et al., 2009; Potter et al., 2012). This attempt to increase awareness has not helped to control recalls. In the last decade, there have been several recalls that have had a huge impact on society in the aspects of public health and economy.

To address continuously evolving food safety requirements, a systematic method should be applied to the evaluation of the performance of the food safety management systems (FSMS), combined with a check on the approach of the company and the level at which core control and assurance activities are executed. The diagnostic tools such as FSMS-diagnostic instruments and microbial assessment can contribute to the measurement of the performance and help gain insight on the actual FSMS and the risk level of existing approach. Selection tools like quality assurance grid and microbial assessment scheme selection tool (Jacxsens et al., 2011) and improvement tools i.e. roadmaps for improvement, protocol for validation and verification and finally, the FSMS support application can help to further elaborate improvements needed to

increase the food safety commitment level and results. Use of these tools should empower the FSMS and lead to safer food products (Jacxsens et al., 2011).

To address issues that are dealt by food companies and to stay up to date with the continuously evolving regulations and food safety practices, companies are expected to come up with novel methods to improve their skills and stay up to date with food safety aspects of the product and it's processing. There is a need for development of tools to empower the food business operators in diagnosing and improving their FSMS. This is especially so for small and medium enterprises (SMEs),as they do not always have the necessary skills, experience, and resources such as finances, staff capabilities, knowledge about current and upcoming regulatory requirements (FSMA) and upcoming changes. (Karipidis, Athanassiadis, Aggelopoulos, & Giompliakis, 2009; Jacxsens et al., 2011).The current food safety management systems (FSMS) in the food industry are uniquely organized by food businesses and are inspected or audited by external auditing bodies, regulatory inspections and/or third-party audits. All audits or inspections include a complete report that discusses observations that may require corrective actions and improvements that are to be made in order to comply with set requirements from external parties (Luning et al., 2009). The growing number of product recalls within the food industry has caused many to question the ability of retailers, producers and suppliers to provide safe products. The key patterns and longitudinal trends in the prevalence of food recalls in the USA, UK and the Republic of Ireland from 2004 to 2010 were reviewed (Potter et al., 2012). Figure 1 shows the number of major recalls and causes of most of the recalls during 2010-14. They have identified a growing trend of product recalls within the food industry, with the majority of recalls detected by regulators rather than by suppliers, firms and distributors within the farm-to-fork supply chain.
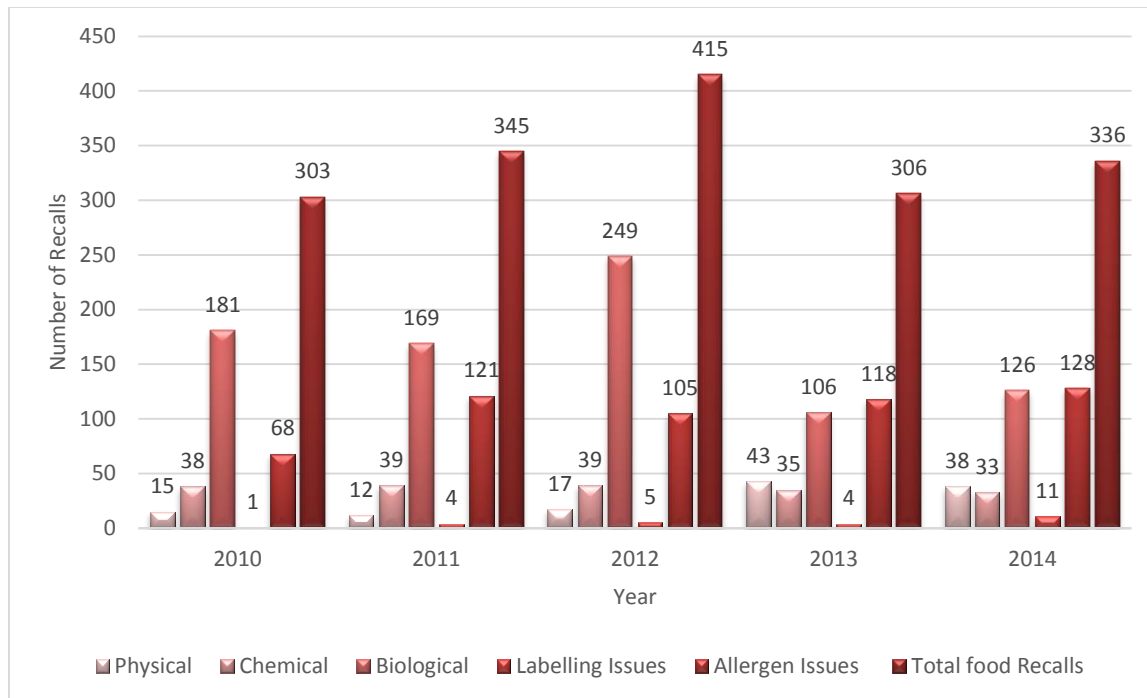
Figure 1 Graph showing number of major recalls and causes of most of the recalls during 2010-14.

It has been a strong belief that the biological hazards are the primary cause for recall. Contrary to this belief, it was identified that operational hazards such as allergen issues and mislabeling issues are the most common cause of product recalls within the food industry (Potter et al, 2012). It is evident that the number of recalls has been on increasing along with the increasing efforts of regulatory bodies and manufacturers to improve food safety. As discussed earlier, it is not always the biological hazard, but the operational hazards such as mislabeling and allergen cross contaminations that are the cause for recall in a majority of the cases (Potter et al, 2012). Although operational issues such as mislabeling and allergen cross contamination are not the root causes of recall associated to death of consumers as much as the microbiological issues, the financial damage caused to the organization due to operational issues is very high. In majority of the cases, the root causes of the issues are training, lack of information, knowledge

and awareness over critical operational aspects. Considering these aspects, there is an imminent need to address the operational issues. There is vast information available through multiple sources such as academic institutions, private training bodies, and regulatory institutions to address the shortage of information to the processors. But, food industry itself remains the greatest repository of knowledge about food safety management, food science experience  and expertise (Sperber, 2005). Hence, it is important to understand that the ultimate responsibility of food safety rests on food industry and they must not only improve their efforts to accept and abide by the legislation based food safety policies. Food processing sectors must also use the intellectual assets to assert the leadership as it was done with initiation, development and advancement in HACCP (Sperber, 2005). To do so, collaboration between food safety professionals from industry, academia, regulatory agencies, third-party audit bodies, and students, (the future food safety professionals) is necessary.  It was indicated that in developing, installing, monitoring, verifying and validating a successful food safety and quality management system depends on a complex mix of managerial, organizational, and technical commitments(Taylor, 2001). Developing such quality management systems is critical for food growers and processors.

Quality management has emerged as a management model for enhancing organizational effectiveness and competitiveness (Dow et al., 1999; Sanchez-Rodriguez and Martinez-Lorente, 2004). Several studies suggest that firms achieve higher levels of profitability and organizational performance through successful implementation of practices associated with quality management (Powell, 1995; Das et al., 2000, Douglas and Judge, 2001; Kaynak, 2003; Mesut, 2009; Hendricks and Singhal, 2005; Kull and Narasimhan, 2010; Sadikoglu and Zehir, 2010). Multiple reports and interviews from the participants and winners of MBNQA and other state level quality

award participants supports the statement that commitment to quality management and improvement systems helps overall organizational improvement in multiple aspects such as profitability, quality, improved customer satisfaction, decrease in product defects and decreased customer complaints. With such aspects proven over and over, the need of quality management and continuous improvement aspects within food safety and product quality issues in food processing aspects could help the organizations to address safety and quality aspects. With the changes in regulatory requirements (FSMA in 2015) and the development of new regulatory and verification mechanisms for the safety and quality of food and agricultural products in recent years, governance in the global food system has been significantly transformed (Hatanaka, Bain, & Busch, 2005). Traditionally, it was government agencies that were responsible for monitoring food safety standards and food quality attributes due to public health concerns. Although regulatory audits (FDA and USDA-FSIS) are in place, with emergence of customer required audits like British Retail Consortium (BRC), Safe Quality Foods (SQF) and PRIMUS GAP, regulatory audits are not as prevalent as the organizations go through third-party and customer audits in majority of the cases. Due to this reason, third-party certification procedures have gained greater importance both in local and the international food business sector. With such globalization of the food system, the merging of the food retail industry, and the rise in private retailer standards have triggered a shift in responsibility for this task to third-party certification bodies (Zuckerman, 1996; Barrientos et al., 2001; Bredahl et al., 2001; Calvin et al., 2001). To meet such requirements, it is important for any organization to realize that they must get employees trained and provide sufficient resources to improve their skills to implement food safety practices before the organization even thinks to establish a strong food safety culture.

In an organization with a good food safety culture, every employee is expected to implement the best practices that represent the shared value system and point out where others may fail (Powell, Jacob, & Chapman, 2011). Organizations can demonstrate a good food safety culture by utilization of wide variety of tools, consequences and incentives to improve the food safety programs. Awareness of current food safety issues reflects the effects by organization to stay up to date and continuously improve food safety programs (Powell et al., 2011).According to Frank Yiannas, organizational success in food safety depends on: "Going beyond traditional training, testing, and inspectional approaches to managing risks. It requires a better understanding of organizational culture and the human dimensions of food safety. To improve the food safety performance of retail or foodservice establishment, an organization with thousands of employees, or a local community, you must change the way people do things. You must change their behavior. In fact, simply put, often times food safety equals behavior" (Yiannas, 2009). Food safety culture is something that differentiates a great organization and an average organization. The strong assumptions within the average organizations with respect to the behavioral aspects such as optimistic bias which means, it will not happen to me; illusion of control which means, everything is going just fine or nothing has gone wrong because I know what I am doing; cognitive dissonance which is the belief that employees know that they are doing wrong but there is a reason and attitudinal ambivalence which means, employees think that there are more important matters (Souza Monteiro, 2009). Although there are several resources for passive learning about food safety culture, food industry itself acts as the greatest resource for information, experience and cost effective best practices. For this reason, there is an imminent requirement for establishing a platform to promote best practice sharing methods within food industry. The values revolving around "best practice sharing" which itself is a great core value

for any business has been one of the greatest advantages of participating in Malcolm Baldrige National Quality Award (MBNQA).

The use of Baldrige approach has been reported to be very successful. In the aspects of food safety, the approach involving best practices is not prevalent or may be nonexistent. Creating such platform promoting it to share best practices is the primary objective and also the core concept behind the entire audit alliance program.  In this audit alliance program food safety and quality programs are linked with Baldrige core values and a new criterion was developed. The idea is to have a platform for knowledge transfer across food industry by promoting the idea of best practice sharing within food industry. Agenda of this paper is to promote an audit alliance in which incorporate aspects of continuous improvement and learning from MBNQA criteria to improve overall food safety and quality aspects of food processing. This program can be used as a tool to evaluate organizational commitment while promoting best practice sharing. The organizational safety and quality system evaluation can be done through a new auditing approach in the audit alliance.

**Methodology:**

The primary objective of the project was to develop and implement a methodology to share best practices among food industry food safety practitioners. To achieve this, an Audit Alliance was formed and an audit criterion was developed focusing on food safety, quality and continuous improvement using the core concepts of MBNQA. Multiple documents were used for the audit purposes depending on the stage of the project. Training material was developed that covers internal audit training, auditor ethics, introduction to third-party auditing, introduction to MBNQA, and audit alliance-audit approach. Third-party audit criteria such as BRC, SQF and

PRIMUS GAP were used for the internal auditing purpose. Audit alliance approach is shown in

the figure 2

**Project steps and approach:**

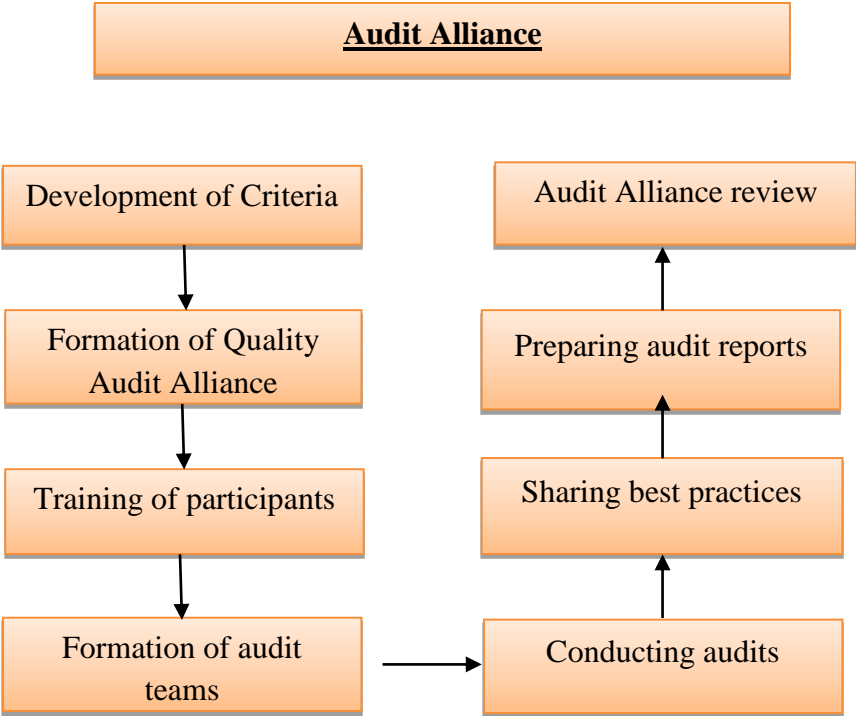The flow chart below shows the major steps involved in the Audit Alliance Program.



Figure 2 Flowchart showing steps involved in the Audit Alliance Program.

In the process of the development of methodology to promote sharing of successful food safety, quality and continuous improvement strategies, the audit alliance was initiated and implemented in the food processing sector. The relevant methods were used in the process are discussed in the next paragraphs.

**Development of criteria:**

The audit alliance criteria had two different audit schemes: Food safety and quality (FSQ) criteria, and adapted GFSI scheme criteria relevant to the program. The organizations were audited against criteria with a numerical scoring system to evaluate food safety and quality parameters along with continuous improvement strategies practiced to achieve performance excellence. This criterion helped evaluate and share the strategic quality improvement practices and provide a common ground for the organizations to compare and learn best practices through the auditing process. FSQ criterion was developed for the study based on the core values in the lines of "Malcolm Baldrige Performance Excellence Criteria" (MBPEC) (Agarwal et al, 2013) but primarily focusing on food safety and performance improvement such as:

- Management commitment;

- Strategic planning;

- Knowledge management;

- Continuous improvement methods;

- Customer Management; and,

- Employee Management.

A scoring system was derived for the evaluation of the organizations systems against this criterion. This scoring system helped to achieve a quantitative comparison of

the listed food safety, product quality and continuous improvement methods of the organization. This scoring system was designed to provide a quantitative review on the current system in a company being audited. The second criterion, GFSI scheme criterion, was focused on assessment of specific GFSI scheme (BRC, SQF and PRIMUS GAP) that was implemented by the organization. One of the GFSI benchmarked schemes (FSSC22000, BRC, SQF, PRIMUS and Global GAP) that were being implemented by the participating organization were adopted and used for the audit purposes. The criteria were developed and adopted to help organizations reassess the existing GFSI scheme along with other important aspects of food safety and quality systems. This audit process was expected to help the companies partially meet the annual internal audit criteria according to the GFSI benchmarked schemes. This process was also expected to provide an outside perspective on the effectiveness of organization's existing food safety and quality policies and procedures. The GFSI schemes may include but not limited to the schemes such as British Retail Consortium (BRC), Safe Quality Foods (SQF), Primus GFS – A Global Food Safety Initiative Scheme, Food Safety Systems Certification 22000 (FSSC 22000), Global GAP (Good Agricultural Practices), and, other GFSI benchmarked schemes that are implemented by organizations that are part of Audit Alliance (AA).

The audit consisted of multiple audit teams with members that were employees of food companies, with considerable amount of experience. AA also included student members who were enrolled in a quality management and auditing course. The author was part of each team throughout the process and actively trained, monitored and participated in AA activities and audits.

An application was made available for the companies recruited to register for the AA. All applications were reviewed and members were accepted based on a criterion. Student participation was an integral part of the AA process with the agenda of training the students and providing on-site experience on handling food safety and quality systems. The students were also trained in HACCP, internal auditing and other food safety GFSI benchmarked schemes and other aspects on which the industry participants were already trained.

All of the AA participants attended a one-day, mandatory auditor training work shop. Employees were fully trained by the author with the help of the professional training staff at Oklahoma State University. Individuals were trained the topics listed in Table 1.1

Table 1.1 Topics covered during the training for registered participants.

| No. | Training topic |
|-----|----------------|
| 1 | Confidentiality & code of conduct |
| 2 | Audit ethics |
| 3 | Audit scope |
| 4 | GFSI criteria |
| 5 | Understanding FSQ criteria |
| 6 | Scoring guidelines |
| 7 | Audit procedure |
| 8 | Methods of audit findings and OFIs |
| 9 | Audit report completion |

A makeup training and refresher training was provided upon request by the participating members. Additional training session was provided for the participants registered after the initial training.

Relevant training was provided to the audit team before the audit by approved trainers who have been through American Society of Quality (ASQ) "train the trainer" training program. The audit teams were formed by the end of the first training day. Each team consisted of least 2 members of the AA, a trained individual with experience in food safety and quality, and at least one student that was enrolled in the program. Few additions to the team were made after second training. After the audit teams were formed, the audit dates were scheduled and communicated. Every participant from a company that applied to be part of the AA participated in an audit in a different company, along with at least 3 other auditors that are a qualified food safety professional. On-site audits were scheduled to last approximately 2 days. During the 2 days of the event, the organizations were audited using FSQ criteria and organization's GFSI scheme criteria. The auditors were expected to completely address the criteria through different mechanisms including observation of documents, monitoring of the processes, and personal interviews.

Once the on-site audit was completed, the quality of the FSQS programs was evaluated based on the number of non-compliances (OFIs) identified by the auditors. A report was submitted to the Audit Alliance for reassessment of the audit findings. Suggestions to address the OFIs were provided to the organization audited along with the final audit report after the audit.

**Discussion:**

By implementing this new process of auditing, the following aspects can be successfully completed.

1. The idea of best practices sharing among food processors can be initiated.

2. Although it was hard to measure "promoting the idea" of best practice sharing, it was evident from the fact that multiple organizations have shown significant interest and were ready to invest time and money on the program reflects success of the program and its intention to promote the best practice sharing by knowledge exchange sessions and audits.

3. An FSQ audit criterion was developed and GFSI schemes were adopted as primary tools to be used in the process to address critical areas of business relevant to food safety, product quality, and continuous improvement. This new criteria, developed by integrating food safety concepts with MBNQA core values, helped participants to make a thorough analysis of their organization's food safety program at a higher level.

4. Multiple audit teams were formed and were sent to participating organizations to observe and document successful strategies and continuous improvement methods implemented by the participating organizations. Observation reports were developed and submitted to the organizations.

5. Audit teams assessed existing GFSI Food Safety and Quality Systems (FSQS) programs such as: SQF; BRC; and PRIMUS. Internal audit observation reports were provided. The audit reports included both observations and non-conformities.

This audit alliance program was implemented over a 6-month period. Multiple organizations were contacted regarding the project and 7 organizations participated along with interested students. All the participants were thoroughly trained on food safety aspects and FSQ criteria. The Kirkpatrick training evaluation method was used and it showed that the participants reacted well about the program and that they learned through the training process. It was observed that the FSQ criteria had shown effect on participants as the participants had reported that they came across new aspects which could help promote food safety culture in the organization.

This is evidence of best practice sharing, although it was not clear how well the learned aspects would fit to the participants' organization relying on a Kirkpatrick Level - 4 evaluation. Based on the inferences drawn from a Mann-Whitney-Wilcoxon test, it was evident that there was a significant difference in learning in the aspects of knowledge, awareness and understanding of food safety, quality and continuous improvement programs.

Limitations and future implications:

Multiple limitations were observed throughout the project implementation process. Sample size was low. As discussed earlier, this could be due to the program being new and possible confidentiality issues between participating organizations. Participant numbers throughout the program were decreased due to normal job changing and personnel moves. Although it was not measured, it was a point of consideration that food industry participants might not have a full commitment on a new criteria that is not mandated by a customer or regulatory body. Reactions to food safety and quality criteria

were much higher and greater participation was monitored in these areas. Kirkpatrick evaluation Level -4 (Results) were not conducted at this time because of the timeline of the project and observations made about organizations current rating against the FSQ criteria. Having Level -4 evaluations might provide more information on how the learning was implemented and results were obtained.

In conclusion, the Audit Alliance was a successful idea that helped to initiate best practice sharing between food companies. Aggressive participation that was obtained by overcoming confidentiality aspects, helped food safety professionals and the participating organizations improve their knowledge, awareness and understanding of food safety, quality and continuous improvement aspects by sharing information between groups. Information sharing helped to identify cost effective methods and also helped to elevate the overall food safety practices of the organizations as well as the community.

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**Appendix G**

**Article - II**

Sharing of successful food safety, quality best practices and continuous improvement strategies Oklahoma Audit Alliance

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Abstract:

Safety and quality of foods has been a growing global concern not only because of the continuing importance of public health but also the significant financial impact on the industry due to food safety and quality issues. Third party and customer audits, and regulatory inspections encourage food safety representatives to meet regulatory and customer requirements. Internal audits help for self-assessment of food safety systems. Although these aspects have been standard practices in the food industry, there is a need for tools to empower the food sector in diagnosing and improving their FSMS by promoting best practice sharing. The Oklahoma Audit Alliance (OAA) was formed with the intention of improving knowledge and awareness of food safety, quality practices, and continuous improvement programs. The underlying agenda of the OAA was to promote best practice sharing with in food industry in the state of Oklahoma. The OAA consisted of participants from food companies, university students studying food science, and other food safety professionals from Oklahoma. Appropriate training was provided to the audit alliance members along with the necessary tools to conduct food safety, product

quality and continuous improvement focused audits. The Kirkpatrick evaluation method was used to study the effectiveness of the program by measuring the increase in awareness, knowledge of food safety and quality as well as understanding on continuous improvement programs. Mann-Whitney-Wilcoxon test was used to test the hypothesis. At $P<0.05$, it was observed that there was a significant increase in knowledge, awareness, and continuous improvement aspects of food safety and quality by participants in the OAA program. This signifies that a knowledge transfer has occurred promoting the idea of best practice sharing.

Keywords: audit alliance, food safety, auditing, internal auditing, GFSI, SQF, BRC

**Introduction:**

Safety and quality of foods is a growing global concern not only because of the continuing importance of public health but also because of the significant financial impact on the industry. Since food safety has become a quality characteristic, food producers consequently are involved in communicating and enacting food safety policies and practices. There are a number of issues that are influencing the evolution of food safety regulations. As one of the measurements of the performance of the quality management system, food producers are required to monitor customer perception as to whether the organization has fulfilled customer requirements with regard to food safety and quality. The current food safety management systems (FSMS) in the food industry are uniquely organized by food businesses and are inspected or audited by external auditing bodies, regulatory inspections, customers and/or third party certification bodies. Audits or inspections include a report that discusses observations that may require

corrective actions and improvements that are to be made in order to comply with set requirements from external parties (Luning et al., 2009). This has been a very effective approach to strengthen food safety systems with excellent policies and procedures, as most of the audits demand mandatory maintenance of records. There is a need for tools to enable the food business operators to diagnose and improve their FSMS. This is especially true for small and medium enterprises (SMEs), as they do not always have the necessary skills, experience, and resources common in larger companies. SME's may be missing finances, staff capabilities, knowledge about current and upcoming regulatory requirements (FSMA) and upcoming changes (Karipidis, Athanassiadis, Aggelopoulos, & Giompliakis, 2009; Jacxsens et al., 2011). Identification of tools required to share the knowledge between the business operators is necessary and could help the small and medium scale food businesses to reassess their food safety and quality management systems. A systematic method should be applied to the evaluation of the food safety performance of the FSMS, combined with a check on the approach of the company and the level at which core control and assurance activities are executed. Internal audits are self-audits performed by the companies. One of the most critical needs of the American food industries is strengthening and support of the food safety and food quality and continuous improvement programs. This requirement to meet high levels of food safety and security requires food processors to undergo rigorous third-party auditing for standardized food safety and defense programs. These include programs such as HACCP and private sector retailer and customer driven Global Food Safety Initiative (GFSI) programs such as the British Retail Consortium (BRC), Safe Quality Foods (SQF), FSSC 22000, Good Manufacturing Practices (GMP), and PRIMUS Global systems. In the

process of elevating the standards of FSMS systems, identification, development and implementation of a methodology is required to share knowledge between business entities which could significantly help food processors; especially small and medium businesses to compare, reassess and improve their food safety and quality management systems.

Powell et al, (2011) states that a culture of food safety is built on a set of shared values that the organizational employees follow to process food in the safest manner. Maintaining a food safety culture means that all the employees such as top management, mid-level managers, supervisors, operators and staff are made aware of the risks associated with the products they produce. They must understand the importance of managing the risks, and continuously improve their abilities to effectively manage those risks in a demonstrable fashion. It is important for any organization to realize that they must get the employees trained and provide sufficient resources to improve their skills to implement food safety practices before the organization can have a strong food safety culture. In an organization with a good food safety culture, each and every employee is expected to implement the best practices that represent the shared value system and point out where others may fail (Powell, Jacob, & Chapman, 2011). Utilizing a wide variety of tools, consequences and incentives, organizations can demonstrate to their employees and customers that a good food safety culture is a part of their organizational strength (Powell et al., 2011).

According to Frank Yiannas, Vice President of Food Safety, Wal-Mart, organizational success in food safety depends on: "Going beyond traditional training, testing, and inspectional approaches to managing risks. It requires a better understanding

of organizational culture and the human dimensions of food safety. To improve the food safety performance of retail or foodservice establishment, an organization with thousands of employees, or a local community, you must change the way people do things. You must change their behavior. In fact, simply put, often times food safety equals behavior" (Yiannas, 2009). Other qualities that directly contribute to food safety performance are leadership commitment, management systems and style, environment, perception of risk involved with products, communication among employees, and communication within the supply chain. Understanding those aspects and identifying and implementing the best strategies to achieve them promotes food safety as a culture instead of as a regulatory requirement. Food safety culture is something that differentiates a great organization from an average organization. The strong assumptions within the average organizations with respect to the behavioral aspects such as optimistic bias, illusion of control and cognitive dissonance (Souza Monteiro, 2009). A good company will always finds the means to overcome negative traits that hinder them moving forward to a stronger food safety culture.

The following are some crucial aspects to be considered by an organization to develop a strong food safety culture within (Yiannas, 2009).

- A system based approach towards food safety, creating, implementing, verifying and reacting to food safety performance expectations;
- Working towards developing expectations beyond risk basis;
- Thinking beyond regulatory requirement;
- Providing appropriate training, education to influence behavior;

- Focus on changing behaviors;

- Developing food safety goals and measurement mechanisms;

- Using consequence based approach to promote change of behavior; and'

- Tying the all the aspects together and taking a collective approach driving traditional food safety management systems towards a behavior based food safety management system, in other words, a food safety culture.

It is evident that the number of recalls has been an increasing trend, along with the increasing efforts from regulatory bodies and manufacturers towards food safety. As discussed earlier, it is not always the biological hazard, but the operational hazard that is the cause for recall in the majority of the cases. Considering this, there is a need to address operational issues. In the majority of the cases, the root causes of the issues are training, lack of information, knowledge and awareness. There is vast information available from multiple sources such as academic institutions, private training bodies, regulatory institutions and their sources. By far, the food industry itself remains the greatest repository of knowledge about food safety management, food science experience and expertise (Sperber, 2005).  It is important to understand that the ultimate responsibility of food safety relies on food industry and they must not only improve their efforts to accept and abide to the legislation based food safety policies but also use the intellectual assets to assert the leadership as it was done with initiation, development and advancement in HACCP (Sperber, 2005). To do so, collaboration between food safety professionals from industry, academia, regulatory agencies, third party audit bodies, and students, the future food safety professional is necessary.  It was indicated that the success in developing, installing, monitoring, verifying and validating a successful food

safety system depends on a complex mix of managerial, organizational, and technical commitments (Taylor, 2001). Such requirements call for a new platforms for learning such as Oklahoma Audit Alliance where multiple organizations come together to share best practices.

The process by which the current food safety systems and the HACCP system evolved was simultaneous and transparent (Sperber, 2005). With respect to process of evolution of current food safety systems to the current standards, various aspects such as voluntary systems based on science and mandatory systems based on legislation were considered. Both GFSI and legislation (FDA & USDA-FSIS) based systems are providing greater transparency and creating greater opacity in our attempts to improve food safety management systems. Greater transparency in food safety practices will promote commitment levels of employees within organization which in turn lays a great foundation for strong food safety culture.

**Third party auditing:**

Auditing systems are classified into four types.

They are:

- First Party Auditing –Also called internal auditing/self-assessment;
- Second Party Auditing – Auditing by company paid, consultant(s);
- Third Party Auditing – Audits by independent organizations with expertise to provide as assessment and verification of company's compliance with established standards and legal and regulatory requirements; and,

- Fourth Party Auditing – Audits that are conducted by Food law, regulations enforcement agencies (Tanner, 2000).

With the changes in regulatory requirements (FSMA) and the development of new regulatory and verification mechanisms for the safety and quality of food and agricultural products in recent years, governance in the global food system has been significantly transformed (Hatanaka, Bain, & Busch, 2005). Traditionally, it was government agencies that were responsible for monitoring food safety standards and food quality attributes due to public health concerns. Although these regulatory audits are in place even with emergence of customer required audits such as BRC, SQF and PRIMUS GAP, regulatory audits standard are not as prevalent as the organizations go through third party and customer audits in majority of the cases. Due to this reason, third party certification procedures have gained great importance in both local and the international food business sector. With such globalization of the food system, the merging of the food retail industry, and the rise in private retailer standards have triggered a shift in responsibility for this task to third party certification bodies (Zuckerman, 1996; Barrientos et al., 2001; Bredahl et al., 2001; Calvin et al., 2001)

Different certification standards have been established to serve as instruments of food safety and quality assurance within the food supply chain (Deaton, 2004; Fulponi, 2006). Meuwissen and Huirne, (2000) states that the key feature of a certification system is that the inspections are carried out by independent third party certification bodies in accordance with standards laid down by external organizations (Albersmeier, Schulze, Jahn, & Spiller, 2009) such as SQF, BRC and FSSC 22000 (Luning & Marcelis, 2006). These food safety audits are conducted by a professionally trained staff from food safety

auditing bodies, also called certification bodies (CB). Food processing facilities which participate in audit programs receive a complete examination and technical assistance in all areas that affect food safety, product integrity, regulatory and other customer requirements. Typically, the process of obtaining third party certification operates in the following way. First, a supplier applies to a particular third party certification body for certification. The third party certification body conducts an optional pre assessment and documentation review of a supplier's facilities and operations. Field audits are also conducted verifying the conformity to states organizational policies and procedures established based on the food safety schemes criteria. When the non-conformities are addressed with corrective conformity is verified, certification body issues a certification and allows the supplier to label its products as certified.

There are a number of reasons why third-party audits are done. These include but are not limited to the following:

- Desire to improve food safety, quality and sanitation
- Customer requirement to verify a vendor's programs
- Potential marketing advantage
- Looking for a third set of eyes
- Troubleshooting
- Not having the resources in-house

Going through the certification process is expected to provide assurances about a product to customers or stakeholders by providing information about the product and processes involved in the production life cycle. The best aspect about the third party

certification process is the claimed independence from other participants involved in food or agricultural production, such as retailers or suppliers where the processors holds the responsibility of the product that is shipped out from their facility (Zuckerman, 1996). Third party certification processes also emphasizes those values such as independence, objective evidence, and transparency in an attempt to increase trust and legitimacy among their customers to limited accountability of the products purchased from suppliers. With such approach in the supply chain where every supplier takes responsibility of the product safety, the overall safety of the food in supply chain is increasing. But the draw backs involved in this third party certification process are the duration of audit and costs associated with the process. Although one can justify the costs by countering with the recall costs, it is important to identify, understand and implement cost effective approaches that are specific to products being processed. This can be achieved by having a methodology to share the best practices with in supply chain as food industry will always be the primary repository for the food safety information. The values revolving around "best practice sharing" which itself is a great core value for any business has been one of the greatest advantages of participating in Malcolm Baldrige National Quality Award. In the next few paragraphs, MBNQA and how its core values can be used in food industry to enhance the food safety knowledge within the industry is discussed.

The use of Baldrige approach has been reported to be very successful. In the aspects of food safety, the approach involving best practices is nonexistent or at least not prevalent. In this project, creating such platform to share best practices is the primary objective and also the core concept behind the entire audit alliance program. The ultimate goal is to

promote the idea of best practice sharing within food industry and to analyze the effectiveness of this program.

Materials and Methods:

Analysis of project effectiveness, as the topic chosen was quiet abstract; the methods available were very limited and obvious. The primary objective of the project was to develop and implement a methodology to share best practice among food industry food safety practitioners. To achieve this, an Audit Alliance was formed and an audit criteria was developed focusing on food safety, quality and continuous improvement. Multiple documents were used for the audit purposes depending on the stage of the project. Training material was developed that covers internal audit training, auditor ethics, introduction to third party auditing, introduction to MBNQA, OAA audit approach. Third party audit criteria such as BRC, SQF and PRIMUS GAP were used for the internal auditing purpose. For the evaluation of the program, 3 different questionnaires were developed. Next few sections elaborates the methodology of project development and implementation.

The OAA audit criteria have two different audit schemes. FSQ Criteria and adopted GFSI scheme criteria relevant to the program. The organizations were audited against criteria with a numerical scoring system to evaluate food safety and quality parameters along with continuous improvement strategies practiced to achieve performance excellence. This criterion helped evaluate and share the strategic quality improvement practices and provide a common ground for the organizations to compare and learn best practices through the auditing process since the participating companies

may not implement the same GFSI Scheme which was used as second criteria to evaluate

food safety systems. This FSQ criterion was developed for the study based on the core

values in the lines of "Malcolm Baldrige Performance Excellence Criteria" (MBPEC)

(Agarwal et al, 2013) but primarily focusing on food safety and performance

improvement such as management commitment, strategic planning, knowledge

management, continuous improvement methods, customer management, and employee

management. Scoring system was derived for the evaluation of the organizations systems

against FSQ criterion. This scoring system helped to achieve a quantitative comparison of

the listed food safety, product quality and continuous improvement methods of the

organization. The other criteria were focused on assessment of GFSI scheme that was

implemented by the organization. One of the GFSI benchmarked schemes (FSSC22000,

BRC, SQF, PRIMUS and Global GAP) that were being implemented by the participating

organization were used for the audit purposes. This GFSI scheme audit process was

expected to help the companies partially meet the annual internal audit criteria according

to the GFSI benchmarked schemes and gain an outside perspective on the effectiveness

of their existing food safety and quality policies and procedures.

Communication was a key factor that contributed to the success of the project.

Good communication with the industry was achieved with the help of the Food and

Agriculture Products Center (FAPC) marketing team and FAPC quality management

team with the author's participation. Outreach was be carried out via the FAPC website,

FAPC flash emails, communication through workshops conducted at FAPC, the FAPC

newsletters, and the industry quality roundtables. On-site meeting with the organizations

was also arranged in order to meet the management teams and help them understand the importance of being a member of the OAA by explaining the advantages.

The OAA consists of multiple audit teams with members that are employees of food companies, primarily within the state of Oklahoma, with considerable amount of experience. OAA also have student members who are enrolled in a quality management and auditing course. All the participants were selected based on relevant education and industrial experience to ensure that there is input from every participant. Student participation was be an integral part of the OAA process with the agenda of training the students and providing on-site experience on handling food safety and quality systems.. The students were also trained in HACCP, internal auditing and other food safety GFSI benchmarked schemes and other aspects on which the industry participants were trained.

All the participants were fully trained with the help of professional training providers from at Robert M Kerr Food and Agricultural Product Center (FAPC). Pre and post tests were conducted to evaluate the competency of training following Kirkpatrick evaluation model level 3 approaches. Auditing individuals were trained on the topics such as confidentiality, audit ethics and code of conduct, audit scopes, understanding the FSQ criteria, methods of audit findings and correction, audit preparation and report writing, objective evidence collection and opportunities for improvement (OFIs) identification classifications. A makeup training and refresher training was provided upon requirement by the participating members. The audit teams were formed by the end of the training day with of at least 2 members of OAA, a trained individual from FAPC and at least one student participant enrolled in the program. On-site audits were conducted over 2 days. During the 2 days of audit, the organizations were audited using FSQ criteria and

organization's GFSI scheme criteria. Once the on-site audit was completed, the quality of

the FSQS programs was evaluated based on the number of non-compliances (OFIs)

identified by the auditors. A report was submitted to the Audit Alliance Committee for

reassessment of the audit findings. Suggestions to address the OFIs were provided to the

organization audited along with the final audit report after the audit.

The data collected to test the effectiveness of the program was the responses to the

survey questionnaire and competency testing of auditing skills of the audit alliance

members before the training verses post conclusion meeting (Kirkpatrick evaluation of

training).

Statistical analysis:

Relevant statistical analysis (mean, standard deviation, Mann-Whitney Wilcoxon test)

was performed based on the sample size of the companies, OAA members and students.

The reason for a relatively small sample size was due to a lack of a strong position of

programs similar to OAA within the state and the fact that the audit alliance was limited

to the Oklahoma food processing sector. The sample size for the survey responses

(number of participants) was n≤19 and n is different in each stage due to the participants

either changing jobs or moving to different organizations during the program cycle.

Testing the effectiveness of the methodology was done throughout the process.

Effectiveness testing includes the use of Kirkpatrick's method of evaluation of learning

and training (Farjad, 2012). Phillips (1991) stated the Kirkpatrick Model was probably

the most well-known framework for classifying areas of Evaluation. Survey results

indicated the majority (81%) of HRD executives attached some level of importance to

evaluation and over half (67%) used the Kirkpatrick Model. (ASTD, 1997) The

Kirkpatrick Model was assessed as a valuable framework designed with four levels of

measure to evaluate the effectiveness of an Educational training. The most influential

framework for the evaluation of training programs has come from Kirkpatrick,

Kirkpatrick method follows a goal-based approach. (Phillips, 1991; Kirkpatrick, 1976). It

was used to help determine if the implemented program is able to deliver the intended

information and help evaluate if the training program has been able to deliver the goals

and objectives in terms of cost incurred and benefits achieved. It was also used to analyze

the parameters such as reaction, learning, and behavior. All the questionnaire responses

relevant to evaluation plan were collected as per the schedule. Pre training questionnaire

response was collected before the internal auditor training. Post training response was

collected after the training. Program conclusion survey data was collected after the audit

process, that is, after the completion of program.

Mann and Whitney (1947) explored the case of unequal sample sizes to provide

tables of critical rank sums for relatively small sample sizes which has been the basis for

the widespread use of the nonparametric two-sample test under limited circumstances and

small samples. In this dissertation, Mann Whitney-Wilcoxon test is used as it is the best

suitable non parametric test for the small sample size scenario.

**Results and Discussion:**

The main purpose of the project is to develop, promote and implement an Oklahoma

Audit Alliance (OAA) and analyze the effectiveness using satisfactory survey based

analysis using Kirkpatrick evaluation model (Level 1, 2 & 3). To meet the above

mentioned goals, multiple audit teams were formed and were sent to participating organizations to observe and document various successful strategies and continuous improvement methods implemented by the participating organizations. Observation reports were developed and submitted to the organizations. Audit teams have also assessed the existing Food Safety and Quality Systems (FSQS) such as SQF, BRC and PRIMUS and internal audit observation reports were provided. The audit reports include both observations and non-conformities. Based on the response to survey questionnaire, the idea of best practices sharing among food processors (Oklahoma food processors) was initiated. Extensive outreach was done and 7 organizations from Oklahoma have participated in the program. Although it is hard to measure "promoting the idea" of best practice sharing, it was evident from the fact that multiple organizations have shown significant interest and were ready to invest time and money on the program reflects success of program and its intension to promote the best practice sharing by knowledge exchange sessions, here in case, audits.

Kirkpatrick evaluation results:

The responses were collected from the trained participants before and after the training and after the conclusion of program, which was after the site visit audits. Figure 1 shows the histogram for specific questions and shows mean, standard deviation of questions related to knowledge, awareness and understanding on food safety, quality and
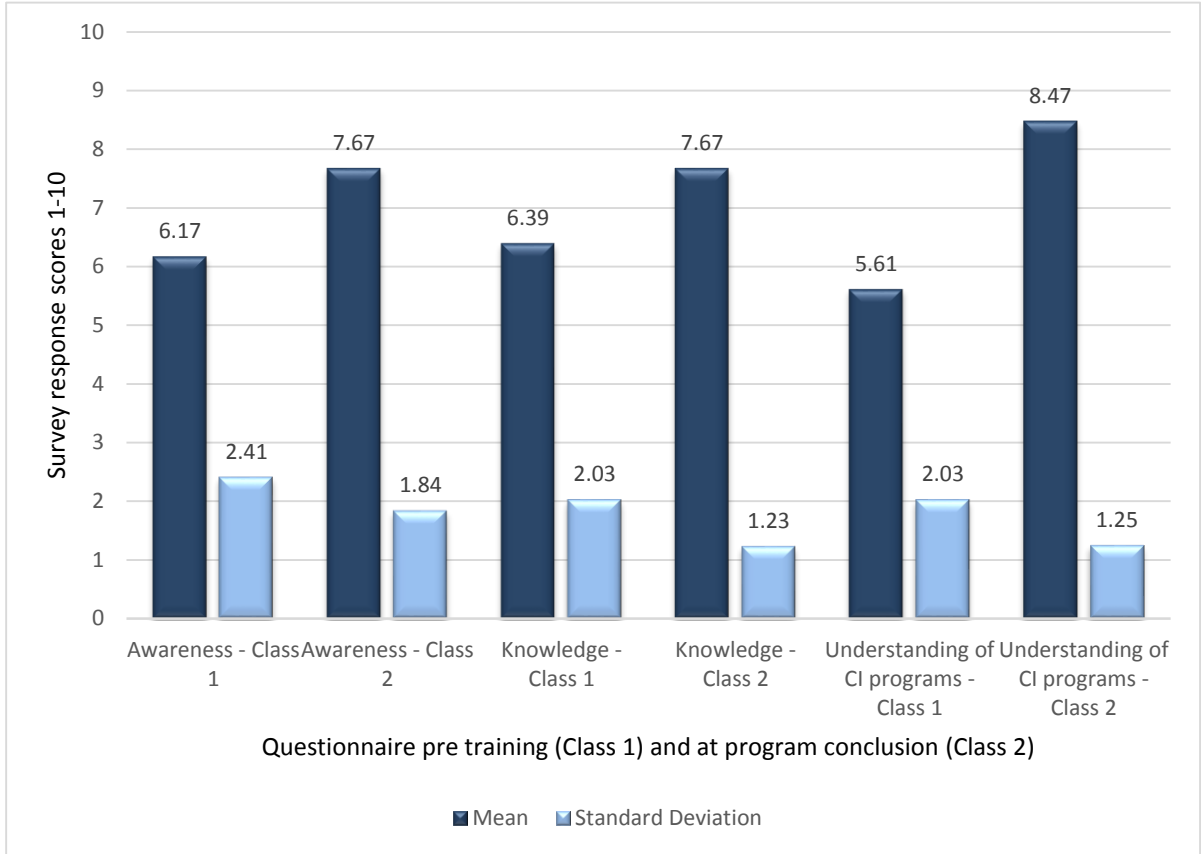
continuous improvement aspects.



Fig 1: Histogram showing the comparison of response scores pre training (Class 1) vs program conclusion (Class 1). Class 2 response scores shows that there is increase in awareness, knowledge and understanding of food safety, quality and continuous improvement programs.

**Non parametric statistical testing results:**

The following table shows the statistical analysis using Mann-Whitney – Wilcoxon non parametric test for increase in awareness on food safety and quality concepts due to participation in OAA program.

Table 1. Mean, Standard Deviation, Median, Range, P-Value (Right sided), P-value (two-sided) for the class 1 (Pre training) and Class 2 (Program conclusion survey) of the trained participants.

| Question | Class | N | Mean(SD) | Median | Range | P-value, (Right-sided) | P-value, (Two-sided) |
|---|---|---|---|---|---|---|---|
| Awareness | 1 | 18 | 6.2 (2.4) | 7.0 | 1.0-10.0 | 0.024 | 0.047 |
| | 2 | 15 | 7.7 (1.8) | 8.0 | 3.0-10.0 | | |
| Knowledge levels | 1 | 18 | 6.4 (2.0) | 7.0 | 3.0-9.0 | 0.046 | 0.092 |
| | 2 | 15 | 7.7 (1.3) | 8.0 | 6.0-10.0 | | |
| Understanding importance of continuous improvement programs on food safety | 1 | 18 | 5.6 (2.0) | 6.0 | 2.0-9.0 | 0.00003 | 0.00005 |
| | 2 | 15 | 8.4 (1.2) | 8.0 | 7.0-10.0 | | |

The statistical analysis was performed to understand increase in knowledge levels over food safety and quality, awareness over concepts of food safety and quality and understanding importance of continuous improvement programs on food safety. Mann Whitney – Wilcoxon ride sided test shows that the right sided test P value is 0.046. As the P-value $< 0.05$, null hypothesis was rejected and the conclusion was that there is a significant difference in participants' knowledge about food safety, product quality. Mann Whitney – Wilcoxon ride sided test shows that the right sided test P value is 0.024. As the P-value $< 0.05$, null hypothesis was rejected and the conclusion was that there is a significant difference in participants' awareness about food safety, product quality. Mann

Whitney – Wilcoxon ride sided test shows that the right sided test P value is 0.00003. As the P-value < 0.05, null hypothesis was rejected and the conclusion was there exists a significant difference in participants understands the importance of continuous improvement with regard to food safety, product quality.

**Conclusion:**

Oklahoma audit alliance program was implemented in state of Oklahoma over a period of 6 months. Multiple organizations were contacted regarding the project and 7 organizations have participated along with students from Oklahoma State University. All the participants were thoroughly trained on food safety aspects and FSQ criteria. Kirkpatrick level 1 evaluation responses have shown that the participants have reacted well about the program and what they learned through the training process. Survey results have shown that the all scores to the post training survey (reaction) are above 7. They have also responded with high scores about 7 (scale 1-10) for the learning aspects of Kirkpatrick Level 2& 3 the survey responses were over 7.5 as well. I was evident that the FSQ criterion that was focused on integrating has shown effect on participants with which they have felt that they came across new aspects.

The comparisons between awareness, knowledge levels and understanding of aspects relevant to food safety, quality and continuous improvement programs that there was an increase in average response scores between class 1 (pre training) and class 2 (Program conclusion). Decrease in standard deviation scores was also observed in class 1 and class 2 response scores. Although FSQ criteria were new to the group of participants, the learning was reported. Every participant have reported that they have learned new

aspects that can be considered "ideas" which can be implemented within their organization with some participants reporting more that 5 new aspects learned. This is an evidence that there has been best practice sharing, although it was not clear how well the learned aspects would fit to the participants organization which is yet to be figures (Kirkpatrick Level -4). Based on the inferences drawn from Mann-Whitney Wilcoxon test, it was evident that there is a significant difference in learning in the aspects of knowledge, awareness and understanding of food safety, quality and continuous improvement programs.

**Limitations and future implications:**

Multiple limitations were observed throughout the project implementation process.

- Sample size was low. ($n \leq 19$). As discussed earlier, this could be due to the program being new and possible confidentiality issues. Also, the project focus was restricted to Oklahoma only.
- Less of participants due to changing jobs and moving to different organizations.
- Although it was not measured, it was a point of consideration that food industry folks might not have a full commitment on the new criteria which is not mandated by any customer or governing body. Reactions to food safety and quality criteria were much more and high participation was monitored.
- Kirkpatrick evaluation Level -4 (Results) was not conducted at this time. Having Level -4 evaluations might provide more information on how the learning was implemented and results were obtained.

In conclusion, Oklahoma Audit Alliance was a successful idea that helped initiate best practice sharing between food companies with in Oklahoma. Aggressive participation by overcoming confidentiality aspects help food safety professionals and the participating organizations to improve their knowledge, awareness and understanding of food safety, quality and continuous improvement aspects by sharing the information within themselves. This could help identify cost effective methods and also help elevate the overall food safety of the organizations as well as the community.

**Acknowledgement:**

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4

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VITA

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