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Pre-professional perceptions of safety and quality concerns in agricultural work environments

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Pre-professional perceptions of safety and quality concerns in agricultural work environments

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NOMENCLATURE

ANOVA	Analysis of variance
ASQ	American Society for Quality
AST	Agriculture Systems Technology
BLS	Bureau of Labor Statistics
CAIS	Childhood Agriculture Injury Survey
CALS	College of Agriculture and Life Sciences
CS-CASH	Central States Center for Agricultural Safety and Health
GLM	General linear model
HOMALS	Homogeneity analysis
ISO	International Organization for Standardization
ISU	Iowa State University
NIOSH	National Institute for Occupational Safety and Health
PCA	Principal Component Analysis
QMS	Quality Management System
TQM	Total Quality Management
USDA	United States Department of Agriculture

ABSTRACT

Pre-professionals in the field of agriculture will play a vital role in the application and implementation of quality and safety policies in agricultural work environments. Yet, no comprehensive study has been completed to understand these pre-professionals' perceptions of quality and safety and how these two factors interact in the agricultural workplace. This study built on the work of Mosher et al. (2012), which measured the interactions between employees' perceptions of safety and quality in an agricultural work environment. To understand how pre-professionals perceive the link between quality and safety, undergraduate students enrolled in the College of Agriculture and Life Sciences (CALS) at Iowa State University were surveyed. Data were collected using a survey instrument adapted from a previous instrument developed by Schwab and Freeman (2002). Analysis of 1017 responses showed that students perceived a high impact of quality practices on the decrease of safety hazards and incidents. Students' perceptions of safety and quality as applied to agricultural work environments varied by gender, with female students perceiving the interaction at a higher level than male students. No significant difference in perceptions was observed based on classification, age group, major, work experience and environment of childhood of the students. This study demonstrates that despite limited academic training in safety and quality, pre-professionals perceive implementation of quality as very important in reducing safety hazards and incidents. In addition, this study suggests that current academic training in safety and quality must be modified to adequately prepare pre-professionals for careers in the field of agriculture.

Keywords: pre-professionals', safety perception, quality perception

CHAPTER 1. INTRODUCTION TO RESEARCH

Background

The field of agriculture is a dangerous occupation that employs one of highest proportions of young workers below the age of 25 years (Westaby et al, 2003; Hard et al, 2006;MaCallum et al, 2012). Young workers generally have the highest risk of occupational injury (Salminen, 2004). Furthermore, young workers in a hazardous occupation like agriculture are at even higher risk for occupational injury (Saha et al., 2008). In the United States, one young worker is killed every three days and 45 young workers are injured each day in an agricultural related incident (Wright et al., 2013).

Current pre-professionals enrolled in the College of Agriculture and Life Sciences are future workers in the field of agriculture. Pre-professionals will directly or indirectly impact the safety of agricultural workplaces. Although many agricultural students have some agricultural safety experiences, previous studies have reported that not all of these experiences are positive in terms of safety perceptions and practices (Sanderson et al., 2010). Yet, little research has explored the perceptions and attitudes agricultural students have toward occupational hazards in the agricultural work environment.

Additionally, technological advancements, changes in health and safety regulations, rising health care and workers compensation costs, increased pressure from environmental groups, litigations and increasing scrutiny of ethics and corporate responsibilities have significantly changed occupational safety over the last two decades (Goetsch, 2008). In modern day work environments, safety management is often viewed as a strategic management tool that can improve a firm's competitiveness, thus indirectly impacting market share, profitability and the firms overall economic and financial performance (Fernandez-Muniz et al., 2009). Safety management has progressed from a traditional approach focused solely on hardware and design to a modern approach based more on cognitive human factors (Mosher, 2013). Previous research has identified safety climate, which is an aggregation of safety perceptions of employees in an organization, as a popular leading indicator of safety performance (Neal at al., 2000; Keren et al., 2009). This mindset shift in advancing safety management from a traditional approach to a holistic approach with strong emphasis on cognitive factors has been less prominent in the agricultural industry (Murphy, 2003). However, recent trends in research literature suggest a growing appreciation for the role of human factors in agricultural safety management (Mosher et al., 2012; Das et al., 2007; Mosher, 2013). Despite the paradigm shift in agricultural safety management little is known how pre-professionals in agriculture perceive occupational safety.

Additionally, concepts and benefits of quality management systems have not been as well appreciated in the agricultural industry (Hurburgh & Lawrence, 2003) as in other industries. According to Hurburgh and Lawrence (2003), globalization and increasing competitive pressures in the last two decades have warranted radical changes in the mindset that typified quality in agriculture previously. Another game changer is the growing influence of legislation starting with U.S. Public Health Security and Bio-Terrorism Preparedness and Response Act of 2002 (‘‘the Bioterrorism Act’’). This has resulted in greater attention to the regulation of the quality processes of agricultural products and supplies. The Bioterrorism Act requires that any facility engaged in manufacturing, processing, packing or holding food for consumption must self-register with the Food and Drug Administration (FDA) and maintain records and information for food traceability purposes.

Also, rising income levels of consumers across developed and developing economies are influencing purchase decisions that were earlier based solely on price (Antle, 1999). According to Antle (1999) in the new economies of agriculture, demand is not only dependent upon price but also non-price attributes like quality of product. Agricultural producers have started to embrace quality management systems to not only improve operating efficiency and meet newer customer demands but also help comply with tighter legal regulations (Laux & Hurburgh, 2010). Despite the growing importance of quality in agriculture, college students in the field of agriculture generally have very little preparation in formal quality management processes.

The growing significance of safety and quality management systems has prompted researchers to examine the relationship and interactions between safety and quality. Starting from Dumas (1987) to Das et al. (2008), the consistent message suggests a strong theoretical link between safety and quality. In agriculture, studies by Roberts and Field (2010) and Freeman et al. (1998) observe that poor quality grain has a higher likelihood to result in increased safety hazards, thus implying a direct connection between safety and quality. Mosher et al. (2012) empirically confirmed that agricultural employees also perceive these long-standing theoretical and practical observations by measuring the interactions between employee perceptions of safety and quality in an agribusiness work environment. However, Mosher et al's research (2012) focused on the agricultural work environment with current employees. Very little is known about how agricultural students perceive the link between safety and quality.

This research project built on the work of Mosher et al. (2012) extending the study of safety and quality perception and their interaction to an academic environment. A thorough understanding of how future young workers perceive the interaction between agricultural safety and quality provides better insight for the development of systems which offer improved protocols for managing safety sensitive products and equipment. A holistic viewpoint of the agricultural workplace would allow hazards and risks to be eliminated and managed with an engineering-focused and behavioral intervention rather than depending solely on educational and enforcement interventions

Purpose of research

The objective of this research study is to explore the understanding of safety and quality perceptions of pre-professional college students who will be entering the agricultural workplace in the near future and are likely to impact safety and quality of agricultural workplaces.
This study will measure student's safety attitudes about the hazards of agriculture and agricultural-specific quality perceptions using an electronically administered survey instrument. This study will investigate if the degree of each student's perception of safety and quality varies significantly by:

- Gender of student
- Classification of student (freshmen, sophomore, junior and senior)
- Age of student
- Environment of childhood of student (farm, small town or large metropolitan city)

This research project will survey how students perceive the connections between safety and quality and validate if these perceptions are consistent with the theoretical and practical connections proposed by the research literature. The study will also examine how various demographic factors contribute to the variability of safety and quality perceptions among students. The goal of this analysis is to develop a predictive model that can determine how particular students will perceive safety and quality.

Data findings will be used to develop a measure of workplace quality climate better tailored to the agricultural workplace and to provide a baseline for further research on the interaction of safety and quality in agricultural environments.

Research questions

The research project was guided by the following questions.

1. Does the student's rating of safety and quality concerns differ based on the age group of student?
2. Does the student's rating of safety and quality concerns differ based on the gender of student?
3. Does the student's rating of safety and quality concerns differ based on the grade classification (freshman, sophomore, junior & senior) of student?
4. Does the student's rating of safety and quality concerns differ based on where the student spent most of their childhood (farm, town or large city)?

CHAPTER 2. LITERATURE REVIEW

This literature review will provide background and context to the research project. It will address five broad topics that ground the research, but the review is not intended to be exhaustive. The topics reviewed are: (1) what is unique about working in the agricultural industry (2) safety management in present day work environments and importance of safety climate (3) quality management systems and the role of human factors in the agricultural industry (4) assessment methodologies researchers have used to measure safety and quality climate (5) theoretical and practical links between occupational safety and quality management.

Agricultural industry

The field of agriculture is often ranked as one of the most hazardous occupations in the United States due to the high rate of work related injuries and deaths (MaCallum et al., 2012) Recent data shows that agriculture was one of only two private industry sectors to experience an increase in rate of injuries and illness in 2011 (BLS, 2012 a).

Much of production agriculture is located on farms. The vast majority of these farms in the United States are owned and operated by individual and family farm households (USDA 2009; Hendricks et al., 2010), adding some safety management challenges. According to the Fair Labor Standards Act (FLSA), youth of any age may be employed at any time, in any occupation in agriculture as long as the farm is owned or operated by their parent or a person standing in place of their parent. According to estimates derived from the latest Childhood Agricultural Injury Survey (CAIS), approximately 1.03 million children and adolescents (younger than 20 years) lived and worked on farms (NIOSH, 2010). Another safety challenge on the farm is that it is difficult to separate the work areas from the non-work or living areas. Hence, unlike other industries, the field of agriculture is unique in that not only are the farm operators at risk but their family members are also exposed to all of the occupational safety hazards on the farm (McCallum et al., 2012).

Safety management and safety climate

Safety management in modern work environments has evolved from a traditional safety program focused on the optimal design of equipment (i.e., an engineering approach), adherence with government-imposed standards (i.e., an enforcement approach), or compliance with the terms of collective agreements (Barling et al., 2003). A more proactive, cross-disciplinary program that requires the execution of systematic safety management systems is more characteristic of current programs (Chang & Liang, 2009). As a result, safety researchers have begun to place strong emphasis on cognitive-based human factors and organizational factors in addition to conventional operational factors such as physical design, machinery operations, and hardware related-measures. One of these factors is safety climate (Mosher, 2013).

The term safety climate was made popular by the seminal work of Zohar (1980) while studying the safety attitudes of workers in manufacturing companies in Israel. Safety climate is an empirical measure that indicates the employee perception of organizational safety compared to other organizational priorities like productivity or quality (Zohar, 1980). Byrom and Corbridge (1997) describe safety climate as employee’s shared perception of how safety management is being operationalized in the workplace at any given moment in time. Neal et al. (2000) suggest that safety climate is a sub component of the overall organizational climate that describes individual perception of safety in the work environment. In a more recent study Zohar (2002) characterizes safety climate as a temporary stage of employee perceptions that changes and evolves based on the individuals who occupy the work environment at that given point in time. Although there are subtle variations in the definition of safety climate across the research literature all of them suggest that safety climate is a measure of safety perception.

Numerous studies have documented the relationship between organizational climate and employee's behavior (Keren et al., 2009; Neal at al., 2000; Zohar, 2002). However, in the safety climate literature there is an ongoing debate regarding the direct effect of safety climate on the employee's behavior. While Zohar (2002), Keren et al (2009), Neal et al (2000) have demonstrated that safety climate provides a motivational antecedent for employee behavior, Cooper and Phillips (2004) argue that the relationship between safety climate and employee behavior is not as clear cut as commonly assumed. The key reason for lack of replication and limited validation of the effect of safety climate on employee behavior may be due to the fact that only a few safety climate instruments have been used multiple times or in multiple environments (Seo et al., 2004). However, the growing body of research in safety climate seems to favor the premise that positive safety perceptions are significantly linked to lower rates of accidents and injury (Neal et al., 2000; Rundmo, 2000; Zohar & Luria, 2005).

Workers in agricultural industries engage in hard physical work, handle machines and animals, and work at heights while performing multiple seasonal tasks under time constraints in order to take advantage of favorable weather conditions (Pfortmueller et al., 2013). This results in long working hours, with high levels of fatigue and sleep deprivation that significantly increase the risk of higher injury rates (Lilley et al., 2012). Data from Bureau of Labor Statistics (BLS) show that between 2003 and 2011, 5,816 agricultural workers died from work-related injuries in the U.S. and the injury rate for agricultural workers in 2011 was over 40 % higher than the rate for all workers (BLS, 2011 b). Crop production agricultural workers' injury rates were 5.5 per 100 workers and animal production agricultural workers’ injury rates were 6.7 per 100 workers while the rate for all non-agriculture workers was 3.8 (BLS, 2012a). Even though preventive efforts such as increased security of agricultural vehicles, installation of fall prevention devices, and more importantly safety education of farm workers have been implemented, fatalities and injuries in the agricultural industry still remain elevated (Karttunen et al., 2013; Pfortmueller et al., 2013).

Merriam-Webster’s dictionary (2013) defines pre-professional as the period preceding a practice of a profession. Based on this definition students in the College of Agriculture and Life Sciences are pre professionals, who upon graduation will directly or indirectly impact the safety of agricultural workplaces. Parsing the enrollment statistics at Iowa State University for academic year 2013 shows that the majority of students enrolled in the college of Agriculture and Life Sciences are less than 25 years old (Iowa State University Enrollment Data, 2013), the age of greatest risk for occupational injury and fatality (Janicak, 2000; Saliminen, 2004; Miller et al., 2007).

Occupational injuries and fatalities of workers based on age of worker have been investigated extensively. Salminen (2004) reviewed 63 studies published in peer-review journals related to nonfatal and fatal injuries of workers below the age of 25 years and concluded that even though young workers are exposed to similar occupational risks as adult workers, published research suggests that they are more likely to be injured than adult workers. The injuries are less likely to be fatal as the majority of the studies on occupational injuries reviewed by Salminen (2004) showed that young workers had lower fatalities than older workers. Even so, data indicate that non-fatal injury rates of teenage workers in some occupations are twice that of adult workers

(Miller et al., 2007). According to Miller et al. (2007), the reasons for such high injury rates among young workers include: inexperience, incomplete physical development, lack of self-confidence and communication skills, the nature of employment, and most importantly, the lack of awareness of work-related hazards. In a study of college-aged individuals, Steinberg (2004) stated that statistics on automobile crashes, binge drinking, contraceptive use, and crime shows that adolescents and college-age individuals take more risks than children or adults. He concluded that such risky behavior in adolescence was quite normal, biologically driven, and, to some extent, inevitable.

Studies have also investigated occupational injuries and fatalities based on the gender of workers. Byrnes et al (1999) conducted a meta-analysis of 150 studies in which risk-taking tendencies of male and female participants were compared. The results of Byrnes et al.'s (1999) study suggested that male participants are more likely to take risks than female participants. Byrnes et al (1999) also suggested that the gender differences in risk perception varied based on age and context.

Young workers in agriculture are exposed to different risks and hazards than are young workers in other industries (Hard & Myers, 2006; Myers & Adekoya, 2001). Several researchers have observed that young workers in agriculture incur more serious injuries and a greater proportion of injuries than the non-agriculture young worker population (Hard et al., 1999). Hard and Myers (2006) analyzed fatality rates of young workers using the Bureau of Labor Statistics database for the years 1992 to 2002. They concluded that fatality rates of young workers in agricultural operations are three times higher on average than those of young workers in all other industries.

Some agriculturally focused research on safety behavior has also been completed. Westaby and Lee (2003) examined safety consciousness, safety knowledge, and dangerous risk taking of high school aged students in agricultural settings. Their longitudinal data suggested that risky behavior was more likely to predict future risky behavior by students in an agricultural setting. Those individuals that held dangerous risk-taking attitudes were more likely to report injuries than individuals without dangerous risk-taking attitudes. Larson-Bright et al. (2007) found another factor that increased the risk for agricultural injury – children who perform tasks for which they are developmentally incapable of doing. Furthermore, Sanderson et al. (2010) found that although children often learned a great deal about safety while working on a family farm, not all those interviewed felt they had the skill level needed to control risk. In most cases, the children's formal training and supervision was very limited, potentially impacting their perceptions of risk and appropriate safety behaviors. The work of Sanderson et al. (2010) does not necessarily conclude that those who work in farm environments are unaware of the risks; rather, it suggests that they are de-sensitized to these risks. Sanderson et al. (2010) conclude that this is true in part because of their continuous exposure to high hazard work environments with few negative safety outcomes. An important fact about safety incidents occurring in agriculture especially in the case of pre professionals and younger adults shows that safety training can play an important role in injury prevention. A study of 14 to 16-year-olds who incurred work-related injuries requiring emergency room visits revealed that over half the teens reported that have had no safety training (Knight, Castillo, & Layne, 1995).

Studies have also investigated college student behavior in non-agriculture settings. Siegel et al. (2009) investigated sexual behavior, contraception, and risk among college students and concluded that sexual behavior among college students differs across the 4 years with regard to rates of intercourse, contraception choice, and responsibility, as well as HIV testing and partner trust. Results from college students' credit card behavior study by Robb and Sharpe (2009) showed that juniors and seniors were found to be more likely to revolve a balance as compared to graduate students, while no such differences were noticed for freshmen or sophomores relative to graduate students. Both Siegel et al. (2009) and Robb and Sharpe (2009) studies suggest that there are differences in behaviors of college students as they progress from freshman to graduate level.

Few researchers have attempted to measure safety perceptions of pre-professional students. Schwab and Freeman (2002) gathered benchmark data for the assessment of safety perceptions and resulting practices as well as baseline knowledge regarding agricultural safety issues as perceived by pre-professional students. Blair et al. (2004) examined safety beliefs and safe behavior of Midwest college students and their findings cast doubt on the effectiveness of current safety education practices for young adults. The work of Blair et al. (2004) built upon the earlier work of Crowe (1995) and found that young adults in 2002 were less safety conscious concerning risky behavior than in 1993 when Crowe (1995) completed his work.

Crowe (1995) work found that safety values were a better predictor of safe practices of college students than the combination of gender, class standing, and geographic region. Crowe also affirmed that young females were more safety conscious than young males. Another important finding by Blair et al. (2004) study was the tendency of college students to become less safety conscious in terms of safety beliefs and safe behavior as they aged. While Blair et al. (2004) and Crowe (1995) provide excellent data on the safety beliefs and safe behaviors of university undergraduates; the focus of the research was on a wide span of unsafe actions. None of these studies examined behaviors specific to pre-professionals in agriculture work environments.

Many agricultural students have some agricultural safety background by way of their life experiences, but these experiences are not necessarily positive in terms of safety perceptions and practices (Sanderson et al., 2010). The high hazard work environment of agriculture coupled with pre-professional workers' safety perceptions and behavior greatly amplifies the risk of occupational injury and death. Yet no comprehensive study on the safety perceptions of university pre-professional agricultural undergraduates exists. Nor has any research examined how perceptions may differ across agricultural disciplines. This research aims to address some of these research gaps.

Quality management systems (QMS) in agriculture

Increasing consumer demand for agriculture produce quality, new government regulations, changes in technology, performance improvements, innovations and new business opportunities are driving significant changes in the way agricultural supply chains function (Van Drop, 2004). To meet the new challenges of globalization and legislation, agricultural industries have started to acknowledge the need for quality management systems to improve efficiency, maintain quality while keeping the transition costs and additional efforts as low as possible (Laux & Hurburgh, 2010; Hurburgh & Lawrence, 2003).

Quality management systems are a collection of processes that aim to meet customers' quality requirements, apply regulatory requirements, enhance customer satisfaction, and achieve continual improvement (Laux, 2007; ASQ, 2000; ISO, 2005a). In the last few decades quality management has evolved from a faddish initiative to that of a practice whose implementation is fundamental and essential for effective management and survival in the competitive business landscape (Nair, 2006). Today quality management is an important organizational goal for businesses and has been associated with benefits such as reducing waste, lowering costs and increasing overall performance of the firm (Sroufe & Curkovic, 2008).

Although the concepts of quality management are being extensively used in many industries, these ideas are relatively new to the agricultural industry (Hurburgh & Lawrence, 2003). Quality of agricultural products is not an absolute concept but a complex definition that includes production processes and environmental aspects in addition to nutritional and taste aspects (Barreira et al, 2009). Increasing consumer demand for information is causing a shift from homogeneous foodstuffs to differentiated food products (Hurburgh, 2003a; 2003b). Product differentiation can be defined by product attributes, or traits, or process related measures through certified and auditable systems (Clause, 2003). In the new economics of agriculture consumers demand for quality differentiated products is not only dependent on the price of the product but also on non-price quality attributes such as nutritional content, safety and convenience characteristics, and environmental impact of production and production processes (Antle, 1999).

The increasing occurrence of food contamination outbreaks has become a cause of concern to agriculture producers and consumers (Van Drop, 2004). The wide coverage of such incidents in news media and professional publications has resulted in governments imposing new legislation to improve agricultural product quality (Beulens et al., 2005). One such legislation is the U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (Food and Drug Administration, 2002). This law requires all companies involved in agriculture and food production in the U.S. to self-register with the Food and Drug Administration (FDA) and to maintain records and information for the purpose of food traceability (Laux & Hurburgh, 2010).

More recently, the Food Safety and Modernization Act (2011) has added further requirements for traceability. Traceability in agriculture is becoming more important as it is becoming a mandatory requirement for agricultural handlers, not just in the U.S. but all other developed countries (Dabbene & Gay, 2011).

Preliminary research on the use of quality management systems in an agricultural setting has demonstrated several benefits including increased operating efficiency, a better ability to meet customer requirements, tighter food security control and greater compliance with new regulations (Laux, 2007; Laux & Hurburgh, 2010). Thakur, Wang and Hurburgh, (2010), proposed a mathematical optimization model that minimized traceability efforts and food safety risks while effectively dealing with customer contract specification and constraints in a bulk commodity handling environment. However, the proposed model does not take human actions into account.

Over the years the scope of quality management systems has evolved from a model limited to basic production to a total quality model that involves all execution functions and actions of owners, managers, and employees (Mantura, 2008). Research literature strongly emphasizes the role of human factors in the successful implementation of quality management systems and business performance (Grover et al., 2006; Mantura, 2008). Successful implementation of a quality program requires the careful integration of technical elements with adequate attention to human factors (Yang & Yang, 2013). Similarly, Luning and Marcelis (2007) suggest that considering only the technical actions that typically dominate quality management models as an overly simplistic approach. Their study lists several “human dynamics” which clearly impact the quality management model, including tasks such as handling out of tolerance products, corrective actions, critical decisions, and appropriate action points.

Mosher, Keren and Hurburgh (2013) state that several factors that may influence the employee's view point on quality within a work environment. One of the factors is the concept of quality climate, which like safety climate represents a collective consensus held about quality facets of organizational functioning (Mosher et al., 2013; Shipton et al., 2008)

Although several researchers have noted the important role of human factors in effective implementation of quality systems, literature on managing quality tend to focus mostly on specific tools (SPC, House of Quality, Six Sigma) or general management frameworks such as TQM, ISO 9000 or Baldridge Awards (Das et al., 2007). Little research has examined whether human perceptions influence the successful implementation of workplace quality initiatives (Gadenne & Sharma, 2009; Fotopoulos, Kafetzopolous & Psmoas, 2009).

A review of research literature clearly shows an increasing emphasis on quality management in agriculture. However, generally pre-professional students in the College of Agriculture and Life Sciences have no formal coursework preparation in quality. A review of the course catalogue for the academic year 2013 at Iowa State University shows very few opportunities for students to learn about the importance of quality management in agriculture. Quality perception could play an important role in workplace quality initiatives (Mosher et al., 2013), yet very little is known about the quality perception of pre-professionals or college students.

Measuring safety and quality climate

The most popular and widely accepted approach to measure safety climate is to use a self-administered questionnaire (Flin et al, 2000; Guldenmund, 2000). Self-administered questionnaires are a valuable tool in social sciences research as they can be easily distributed among large groups of people in a relatively short period of time (Guldenmund, 2000). According to Guldenmund (2007), although the data results from a questionnaire can include a lot of random and unwanted ‘noise’, this effect can be mitigated by using a large sample size so that unwanted influences are unsystematic and normally distributed.

In order to develop an effective safety climate questionnaire Guldenmund (2007) recommends to start with an initial draft using the descriptive model of safety climate and then using the results of previous research construct the final version of the questionnaire. Typically a self-administered questionnaire is developed using a step-by-step process as mentioned below (Guldenmund, 2000):

1) Define the scope of research in area of interest
2) Research and identify measurable attributes that are relevant to the scope
3) Develop a questionnaire
4) Pre-test and validate the questionnaire in a pilot study on a relevant population
5) Make modifications to the questionnaire if necessary based on the finding of the pilot study
6) Administer the questionnaire to the actual target population, collect and analyze the data

Since safety climate is multi-dimensional, the results of the survey are initially analyzed using methods like factor analysis (FA) or principal components analysis (PCA) if linear relations between dependent and independent variables are assumed, or techniques like HOMALS or PRINCALS, where such linearity is not assumed (Guldenmund, 2000). According to Guldenmund (2000) these analyses methods result in factors, principal components or dimensions, which are the subject to secondary analysis used to build various predictive models.

Survey questionnaires have also been used to measure quality climate. For example Shipton et al. (2008) used an annual employee survey to explore the impact of quality climate on hospital performance. Qiu et al. (2012) used a questionnaire to measure organizational quality climate of a rubber products factory located in North China. Mosher et al. (2012) also used a survey questionnaire to measure the interaction between safety and quality in an agricultural setting.

Even though survey questionnaires have been the popular approach to measure both safety and quality climate individually, no research has been done to measure the interaction of safety and quality of pre-professional college students using surveys.

Link between safety and quality

The concept of total safety that integrates authentic caring and quality is not achieved by complex or technical methods but rather by mastering the simple concept of human elements (Blair, 1996). Researchers and experts from several academic areas have noted the importance of human factors as the most critical element in the success of safety and quality programs thus suggesting link a between safety and quality (Deming, 2000; Das et al., 2008; Nobel, 2000; Mosher et al, 2013)

One of the first contributors who suggested the integration of safety and quality was Dumas (1987). After looking for cases of successful quality programs in more than 200 companies over a period of 5 years, Dumas discovered that safety programs were a direct analogy of quality programs and both of them shared the same components and needs. One of the important conclusions of his study was that safety is a dimension of quality since elimination of defects includes the elimination of unsafe practices (Dumas, 1987). While reviewing behaviorally based safety management, Krause and Hidley (1989) found that quality improvement and accident prevention are not only compatible but essentially the same. Additionally Minter (1991) discussed how quality principles were used at Unacol Chemicals and Minerals Company to develop their safety improvement process. Minter's (1991) work affirmed that if safety was viewed as a consequence of making things well then such a program would definitely result in improved quality (Herrero et al., 2002).

Safety practitioners in industrial companies have regularly adopted various tools and techniques that have their roots in quality management to achieve improvements in safety performance (Van Scyoc, 2008). Concepts such as the "plan, do, check, act" improvement loop, statistical analysis of incidents (non-conformities), and performance trending popularized by Deming (2000) when applied to process safety have shown a significant positive effect on health safety and environmental management performance. Levine and Toffel (2010) conducted an empirical study to examine how the implementation of an ISO 9001 quality management system affected organizational outcomes like employee health and safety. Their analysis demonstrated that companies that adopted ISO based quality systems had far lower fatalities when matched with non-ISO firms within their industry. They also conclude adopters were more likely to report no injuries for workers compensation in the years following the adoption.

Researchers and practitioners in occupational health and safety have suggested implementing integrated management systems that incorporates all the considerations for managing quality and safety (Levine & Toffel, 2010; Barbeau et al., 2004). Nobel (2000) makes a strong case for the integration of disparate management systems in quality, environmental, health and safety into one organizational system. He suggested the elements of these various systems, once integrated, would become components of overall systems since the underlying principles of employee involvement, management leadership, process consistency, prevention and continuous improvement are totally congruent and undifferentiated. Hence, in some companies, departments charged with managing quality also manage employee health and safety since applying tools of continuous improvement like an ISO based system can greatly improve occupational safety (Levine & Toffel, 2010).

While exploring behavioral theories and models in safety education, Murphy (2003) also suggested several similarities between behavior-based safety and Deming's Total Quality Management (TQM) methods. According to Murphy the operational goals of safety and quality align very well as they are both critical for organizational excellence. He also noted that actions and core processes such as the measurement of targeted factors, the use of data to understand variation and quantify relationships between system variables, and learning from feedback and continuous improvement are all similar and important in the management of both safety and quality.

Das et al. (2008) took exploratory steps towards understanding the role of safety perceptions in quality outcomes. In their study, they suggest that motivational theory can explain employee behavior, which forms the link between safety and quality. Hierarchical theories such as Maslow's Hierarchy of Needs, states that needs at a lower level must be satisfied before needs at higher levels can be addressed. Das et al. (2008) suggest that safety is a basic need and when an organization is not meeting an employee's basic needs, it is highly unlikely that the employee will be motivated to pursue organizational goals such as quality improvement. However they also suggest motivational theory alone is not sufficient to completely understand how safety perception affects quality.

In a data based evaluation of the relationships between occupational safety and operational performance, Veltri et al. (2007) suggest that safety and operating performance measures such as quality are closely tied. They also recommend that safety function should not be focused entirely on maintaining regulatory compliance. Instead safety should be used as a strategic tool to positively impact productivity, quality and operating performance.

Previous research within agricultural environments has also suggested a practical connection between safety and quality. In one such study, Freeman et al. (1998) reviewed grain engulfments at commercial grain elevators and found that low quality grain had a higher likelihood of safety concerns. Out-of-condition grain is a well-documented safety hazard in agriculture (Mosher et al, 2012). Freeman et al. (1998) analyzed data of U.S. grain engulfments recorded by Purdue University, which includes recorded incidents since 1978, and found that out-of-condition grain played a significant role in 81% of incidents. Similarly while summarizing grain engulfments in the U.S. in 2009, Roberts and Field (2010) noted a positive relationship between out-of-condition grain and the probability of engulfment.

Evans, Michael, Wiedenbeck and Ray (2005) examined the relationship between employees' perceptions of productivity and quality climate and safety related events in a wood manufacturing company. They suggested that increased emphasis on productivity is related to an increased number of safety incidents while increased emphasis on safety relative to productivity resulted in fewer incidents. They conclude that organizational climates such as productivity and quality climates are a factor in safety related incidents and that management must strike a better balance between productivity, quality, and safety to manage the perennial conflict between productivity and employee safety.

In a more recent study, Mosher et al. (2012) further explored these practical connections by collecting survey data from employees in an agricultural workplace. Their work demonstrated a significant and positive relationship between safety climate and quality climate perceptions of employees, thus empirically confirming the long-standing theoretical and practical observations by previous researchers that the management of safety and quality are closely aligned. Although agricultural employees do not seem to lack knowledge on the alignment of safety and quality, addressing the risks behaviorally remains a challenge for safety researchers and practitioners alike.

Myers (2006) suggests that when addressing risks of agricultural work environments, safety professionals must focus on eliminating risks rather than simply controlling them. He concludes that several emerging technologies can facilitate the elimination and mitigation of safety risks. Hurburgh and Lawrence (2003) suggest that quality management is one potential tool in eliminating and managing some agricultural safety risks as well as some of the conditions that promote safety risks.

Students who work in engineering and technology sectors of the agricultural industry will be on the front line in the development of these interventions. Therefore, understanding how workers with diverse exposures to agriculture perceive and evaluate safety and quality in the agricultural work environment is an important component of educating both the pre-professional and professional audiences. A thorough understanding of the interaction between agricultural safety and quality provides better insight for the development of systems which offer improved protocols for managing safety sensitive products and equipment, allowing hazards and risks to be eliminated and managed with an engineering-focused intervention rather than depending solely on educational and enforcement interventions.

Although a strong positive correlation between low agricultural quality and occupational safety risk has been documented (Das et al., 2008; Mosher et al., 2012), college students may not be aware the two concepts are associated. While college students have some agricultural safety knowledge from both classroom and life experiences, agricultural undergraduates generally have little exposure to the principles of quality management. Furthermore, little research has examined the interaction between safety and quality climate perceptions in this setting nor has a comprehensive study been completed on how undergraduates in agriculture perceive the interaction between quality and safety. The aim of this research is to partially address this gap in knowledge by surveying undergraduate students studying within agricultural disciplines.

CHAPTER 3. METHODOLOGY

Introduction

The aim of this study was to examine the interaction of safety and quality climate perceptions of pre-professional students in the disciplines of agriculture and life sciences. To investigate the perception of safety and quality concerns of pre-professional agricultural students, a survey instrument was designed using the tailored design method (Dillman, 2000). The study was conducted at Iowa State University located in Ames, Iowa. The population included all 4035 undergraduate students enrolled in College of Agriculture and Life Sciences (CALS) for the fall 2013 semester. The survey was administered to students electronically using their University email account for delivery.

Survey instrument construction

The intended research study proposed to measure the interaction of safety and quality climate perception of pre-professional students, through the utilization of a survey questionnaire. The survey instrument consisted of 17 questions. Three of the 17 questions in the questionnaire had multiple sub-parts to the main question.

Development of the questionnaire involved a multi-step process. In the first step, a multidisciplinary systematic review of previous research work in safety climate (Schwab & Freeman, 2002; Zohar & Luria, 2005; Johnson, 2007), quality climate (Barreira et al, 2009; Shipton et al., 2008), safety and quality relationships (Mosher et al, 2012) was examined. Next, the various research articles examined in the previous step were evaluated based on the following criteria to identify the most relevant research studies:

- Safety & Quality climate studies in academic settings

OR

- Safety and Quality climate studies in agricultural settings

Of the systematic reviews examined in the first step, the study by Schwab and Freeman (2002) was the only study conducted in an academic setting. Schwab and Freeman (2002) examined safety perceptions of students in the Agricultural Systems Technology (AST) major at Iowa State University. In their study, Schwab and Freeman developed a safety climate survey instrument that they used to survey students over a period of 8 years. Their instrument successfully collected baseline data that were later analyzed to gain an understanding of AST student's perceptions of agricultural hazards and practiced safety behavior. The questionnaire developed by Schwab and Freeman (2002) also included sections where demographic information of students was collected.

The work of Mosher et al. (2012) examining the interaction between safety and quality climate was conducted in an agricultural setting. In their study, Mosher et al. (2012) used two survey instruments - one to measure safety climate and the other to measure quality climate. The safety climate instrument used by Mosher et al. (2012) to measure employees' safety perception at three grain handling facilities was previously developed and validated by Zohar and Luria (2005). Johnson (2007) provided further validation of the safety instrument developed by Zohar and Luria (2005).

To measure quality climate, Mosher et al. (2012) constructed a survey instrument based on the validated safety instrument of Zohar and Luria (2005). Mosher et al. (2012) stated that, to build the quality climate instrument based on the safety instrument some of the items had to be ‘slightly modified’ to reflect a quality environment. However, the scale used in the quality climate instrument was essentially the same as the scale used in safety climate instrument.

To construct a survey instrument for this study, the safety climate instrument used by Schwab and Freeman (2002) was used as a starting point. To incorporate the quality aspect, the items in Schwab and Freeman (2002) were slightly modified, using the work of Mosher et al. (2012) as a guideline. Then, a set of questions to capture demographics information of survey participants such as age group, gender, year in college (grade classification), and ethnicity were added. The measurement scales used in this questionnaire were the same as the scales in the safety climate instrument of Schwab and Freeman (2002).

The questionnaire was then pilot tested. Undergraduate senior year students in the College of Agriculture and Life Sciences (CALS) who had filed for graduation in the summer semester of 2013 academic year were surveyed. The preliminary questionnaire was administered to these students (N=45) via a web-based tool. Based on the response to the survey in the pilot study minor modifications were made to increase clarity of survey instruments.

The final version of questionnaire, constructed by using work of Schwab and Freeman (2002) and Mosher et al. (2012) as a theoretical base and then pilot testing with a small group of students, is consistent with the approach suggested by Guldenmund (2007).

Survey instrument description

In order to measure students’ perception of safety and quality, a variation of the 5-point Likert scale was used in the survey questionnaire. The Likert scale in this case included levels such as “Strongly disagree, Disagree, Neutral, Agree, Strongly agree.” Survey participants specified their level of agreement with a statement or question by choosing one of the 5 options.

Survey instruments used by Schwab and Freeman (2002) and Mosher et al. (2012) also used a Likert-based scale.

The final version of the questionnaire consisted of 17 items. Of the 17 statements the last 3 statements had multiple parts to the main question. The questionnaire was organized by the following areas of interest:

Table 3.1
Questionnaire sections

Areas of Interest	Number of Questions
Age Validation	1
Demographics	5
Agricultural Experience	4
Awareness and Knowledge	4
Impact of Quality Management Systems on Safety Hazards	1
Opinion on Safety and Quality	1
Impact of quality management systems on safety incidents	1
Total	17

Age Validation: This section consisted of only one question. This question required participants to declare if they were 18 years or older, which was the minimum age criterion for participating in the survey. Participants were required to respond by choosing one of the two options YES or NO. As the survey was administered electronically, participants who declared they are not 18 years old were not able to proceed further in the survey. Surveys from those who did proceed despite not being 18 years old were dropped from the sample.

Demographics: The second section of the questionnaire consisting of 5 questions was designed to collect demographic information of survey participants. Participants were asked to provide their gender, the age group they belonged to, current grade classification (year in college), ethnicity, and the environment where they spent most of their childhood. The final question about where students spent their childhood asked specifically if they grew up on a farm, in a small town, or in a city.

Agricultural Experience: This section consisting of 4 questions was designed such that survey participants could describe their work experience in the agricultural industry. In the first question, designed as a dichotomous question with Yes or No response options, participants were asked if they had any experience working in an agricultural industry. In the next 3 questions participants qualified their agricultural work experience and expertise in managing safety and quality by choosing one of the 5 options on a Likert scale. The response options ranged from Low Experience to High Experience.

Awareness and Knowledge: In this section consisting of 4 questions, participants were asked to qualify their awareness of safety and quality management in agriculture and the perceived importance of safety and quality management practices in an agricultural industry. All 4 questions in this section were designed to use a 5-point Likert scale. In the first two questions the response options ranged from Very Unaware to Very Aware. In the remaining 2 questions the response options ranged from Not at all Important to Very Important.

Impact of quality management systems on safety hazards: This section consists of only one question with multiple parts, asking participants the impact of quality management systems on the reduction of 12 different safety hazards, common in agricultural industries. The safety hazards used in the study questionnaire were drawn from Schwab and Freeman (2002) and include:

1) Tractor rollovers
2) Injuries caused by a fall
3) Catching clothing on a power take off (PTO)

4) Electrocution hazards
5) Pesticide exposure or spills
6) Contact with anhydrous ammonia
7) Suffocation hazards in a grain bin or wagon
8) Fires hazards
9) Injuries resulting from animals
10) Air quality in confined building
11) Gases from manure pits or silos
12) Health problems resulting from grain, dust or mold

Based on their perception of the safety risk, participants would pick one of the 5 Likert scale options ranging from Low or no Impact to High Impact, for each of the 12 safety hazards.

Opinion on Safety and Quality: In this section participants were asked their opinion on issues related to occupational safety and quality practices in the agricultural industry. This question had four statements:

1) The concept of quality in the agricultural industry is as simple and clear as it is in a manufacturing environment
2) Young adults and students in the agricultural industry are not well versed in quality management concepts
3) Occupational safety levels in agricultural industries impact the level of quality practices within a workplace
4) Age and experience impact quality practices

Participants were asked to state their opinion by selecting one of five options. The range of values used to record participant opinions ranged from Strongly Disagree to Strongly Agree.

Impact of quality management systems on safety incidents: The last section of the questionnaire consisted of only one question with multiple parts. Participants were asked how quality management systems could help reduce the most common safety concerns in the agricultural industry. Safety incidents used in the study questionnaire were drawn from Schwab and Freeman (2002) and include:

1) Incidents caused by tractor rollovers
2) Injuries caused by a fall
3) Getting clothing caught in PTO unit
4) Electrocution incidents
5) Pesticide exposure or spills
6) Injuries with hydrous ammonia
7) Suffocation in a grain bin or wagon
8) Fire incidents
9) Injuries from animals
10) Health problems caused from air in confined building
11) Gases from manure pits or silos
12) Health problems caused by grain, dust or mold

Based on their perception, participants would pick one of the 5 Likert scale options ranging from Little or no Reduction to Significant Reduction.

The questionnaire used in this study was reviewed and declared exempt from further human subjects review by Iowa State University's Institutional Review Board. Survey Monkey (www.surveymonkey.com) a web-based application was used to administer the survey questionnaire in the pilot test process as well as the final version to the target population.

Participants

The survey was sent to all undergraduate students enrolled in College of Agriculture and Life Sciences (CALS) for fall semester 2013. The list of enrolled students for fall 2013 was obtained from the Registrar's office at Iowa State University. The complete list showed 4,035 students in 15 academic departments and 28 degree programs (majors) administered by the College of Agriculture and Life Sciences. These academic departments include:

- Agricultural and Biosystems Engineering
- Agricultural Education and Studies
- Agronomy
- Animal Science
- Biochemistry, Biophysics, and Molecular Biology
- Ecology, Evolution and Organismal Biology
- Economics
- Food Science and Human Nutrition
- Genetics, Development and Cell Biology
- Horticulture
- Natural Resource Ecology and Management
- Plant Pathology and Microbiology
- Sociology
- Statistics

Prior to sending the actual survey questionnaire, all participants were sent a pre-survey notification email stating that they could expect a survey questionnaire in the next few days.

Dillman (2000) recommended mailing pre-survey notification to all participants a few days before sending survey questionnaire to generate better response rates.

Two days after the pre-notification email, the survey questionnaire used in this study was administered to all participants using Survey Monkey. Along with the survey questionnaire a consent letter was also sent to all participants clearly explaining the purpose and aim of the study and informing participants that involvement in the study was completely voluntary. Participants were encouraged to ask clarifying questions about the survey questionnaire. Also, participants were provided with technical assistance in case any difficulty arose with the web-based delivery.

Hypotheses

The following research hypotheses guided data collection. Results outlined in the next chapter will provide information needed to address each of the following hypotheses:

- Hypothesis 1: The students rating of safety and quality concerns do not differ based on the age group of the students.
- Hypothesis 2: The students rating of safety and quality concerns do not differ based on the gender of the students.
- Hypothesis 3: The students rating of safety and quality concerns do not differ based on the grade classification (freshman, sophomore, junior & senior) of the students.
- Hypothesis 4: The students rating of safety and quality concerns does not differ based on where the students spent most of their childhood (farm, town, or large city)

Study variables

Participants' gender, age group, grade classification, and place where they spent their childhood were used as independent variables. The impact of quality management systems on safety hazards section in the questionnaire was used to determine the students' safety and quality concerns. The 12 safety and quality concerns were found to be highly correlated. Therefore, a factor analysis was performed to determine the structure of a composite variable that best represented student perceptions of safety and quality concerns (Bryman & Cramer, 2009).

Date analysis

This study used a quantitative objective based research methodology. Data analysis was conducted using statistical software SAS version 9.3. Descriptive, comparative, and inferential statistics were used to test the hypotheses in this study. Specifically, in addition to the factor analysis performed to aggregate the principal components representing students' safety and quality perceptions, other statistical operations were also performed. These include: bivariate correlation, linear regression techniques, and significance tests.

CHAPTER 4. RESULTS AND DISCUSSIONS

Introduction

This chapter presents the results of the analysis undertaken to answer the following research questions.

1. Do students perceptions of safety and quality concerns differ based on the age group of students?
2. Do students perceptions of safety and quality concerns differ based on the gender of the students?
3. Do students perceptions of safety and quality concerns based on the grade classification (freshman, sophomore, junior & senior) of the students?
4. Do students perceptions of safety and quality concerns based on where the students spent most of their childhood (farm, town, or large city)?

First, a summary of the data collected will be presented. Then, the results from the statistical analysis will be discussed.

Survey statistics

Initially the survey questionnaire was to be sent to all 4035 undergraduate students enrolled in College of Agriculture and Life Sciences at Iowa State University. Since 94 students had opted out surveys, the actual number of students receiving the survey questionnaire was 3941. Of those surveyed, 1017 responses were received with 933 usable for data analysis. The response rate for all responses was 25.8% while 23.8% was the response rate for usable responses.

A response rate of 25.8% is at the top of the range of 10-25% associated with most online surveys (Sauermann & Roach, 2013). Further-more, according to Sauermann and Roach (2013), benefits of higher response rates are:

- Larger number of responses increases statistical validity
- Enhanced ability to detect significant relationships among measures of interest
- Ability to conduct empirical analyses for different subsets of the population
- Provide insights into moderating effects and heterogeneity

Survey participants versus population

Participation in this study was voluntary. Usually studies with voluntary participation, have an increased probability of responses from participants who feel strongly about the issue in question and may favor certain outcomes (Moore, 2001). Hence drawing statistical conclusions in such cases can be problematic.

In order to determine if the 1017 participants who responded to this survey questionnaire were representative of the undergraduate student population a Chi-square-test was conducted for each of the categorical variables: gender, classification, department and age group. The p-value results for the chi-square tests are shown in Table 4.1 below

Table 4.1

Chi-square Test results for Sample vs. population comparison

Categorical variable	p-value
Gender	<0.0001
Classification	0.001
Department	0.0009
Age group	0.0005

$\alpha = 0.05$

The p-values below 0.05 in Table 4.1 suggested that the sample may not be a good representation of the population based solely on the Chi-square test with a significance level of $\alpha = 0.05$. However, further analysis by comparing the population proportions with sample proportions by gender, classification, age group and department major showed that in most cases the sample proportion was very close to the population proportion. The small difference in proportions between population and sample are normal for such survey studies. Hence, it was decided to **overrule the Chi-square test results,** thus concluding the 1017 participants who responded are representative of the population. The next several tables display the alignment between the population characteristics and the sample characteristics. To demonstrate the representativeness of the survey participants to the overall population Tables 4.2, 4.3, 4.4 and 4.5 reports the percentage of participants based on gender, grade classification, age group and department major respectively in comparison to the population gender percentages.

Table 4.2

Sample versus population: By gender

Gender	Population	%	Sample	%
Female	1920	47.6%	615	60.5%
Male	2115	52.4%	402	39.5%
Grand Total	4035	100.0%	1017	100.0%

Table 4.3

Sample versus population: By academic classification

Classification	Population	%	Sample	%
Freshman	900	22.3%	285	28.0%
Sophomore	856	21.2%	205	20.1%
Junior	1061	26.3%	257	25.3%
Senior	1159	28.7%	257	25.3%
Non-Degree-1	16	0.4%	4	0.4%
Non-Degree-2	43	1.1%	9	0.9%
Grand Total	4035	100.0%	1017	100.0%

Table 4.4

Sample versus population: By age group

Age group	Population	%	Sample	%
18-20 yrs.	2181	54.0%	626	61.6%
21-22 yrs.	1362	33.8%	286	28.1%
23-24 yrs.	261	6.5%	53	5.2%
25-26 yrs.	86	2.1%	18	1.8%
26 yrs. and above	145	3.6%	34	3.3%
Grand Total	4035	100.0%	1017	100.0%

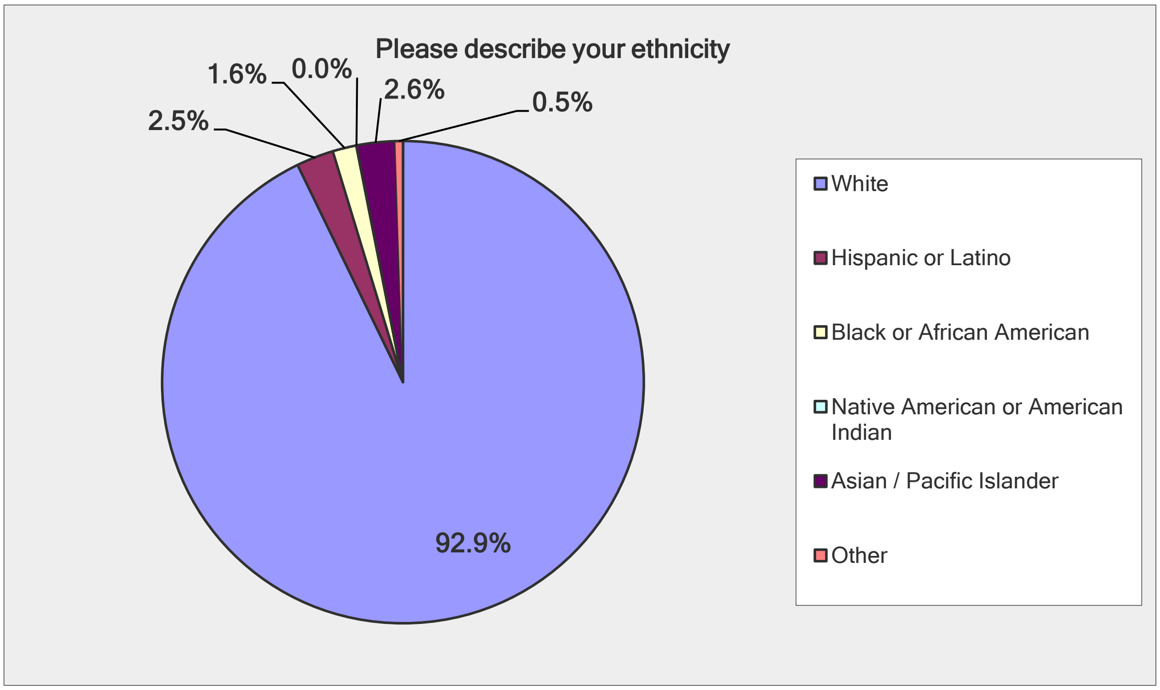
Table 4.5
Sample versus population: By major

No.	Department	Population	%	Sample	%
1	Animal Ecology	338	8.4%	75	7.4%
2	Agricultural Business	458	11.4%	122	12.040%
3	Agricultural Specials	59	1.5%	13	1.3%
4	Agricultural Studies	359	8.9%	68	6.7%
5	AG X	60	1.5%	18	1.8%
6	Agricultural Biochemistry	23	0.6%	6	0.6%
7	Agricultural and Life Sciences Education	133	3.3%	37	3.6%
8	Agronomy	274	6.8%	70	6.9%
9	Animal Science	861	21.3%	257	25.3%
10	Agricultural Systems Technology	208	5.2%	42	4.1%
11	Biology	278	6.9%	71	7.0%
12	Culinary Science	15	0.4%	4	0.4%
13	Dietetics	23	0.6%	5	0.59%
14	Dairy Science	58	1.4%	15	1.5%
15	Environmental Science	78	1.9%	21	2.1%
16	Entomology	1	0.0%	0	0.00%
17	Forestry	95	2.4%	10	1.0%
18	Food Science	49	1.2%	20	2.0%
19	Genetics	62	1.5%	22	2.2%
20	General Pre-veterinary Medicine	90	2.2%	33	3.3%
21	Global Resource Systems	63	1.6%	22	2.2%
22	Horticulture	124	3.1%	19	1.9%
23	Industrial Technology	180	4.5%	32	3.2%
24	Insect Science	11	0.3%	4	0.4%
25	Microbiology	94	2.3%	22	2.2%
26	Nutritional Science	11	0.3%	3	0.3%
27	Public Service and Administration in Agriculture	25	0.6%	3	0.3%
28	Pre-Diet and Exercise	5	0.1%	3	0.3%
	Grand Total	4035	100.0%	1017	100.00%

Ethnicity

More than 90% of the participants described their ethnicity as White, while a small fraction of the participants described their ethnicity as Hispanic or Latino, Black or African American and Asian/Pacific Islander as shown in Figure 4.1

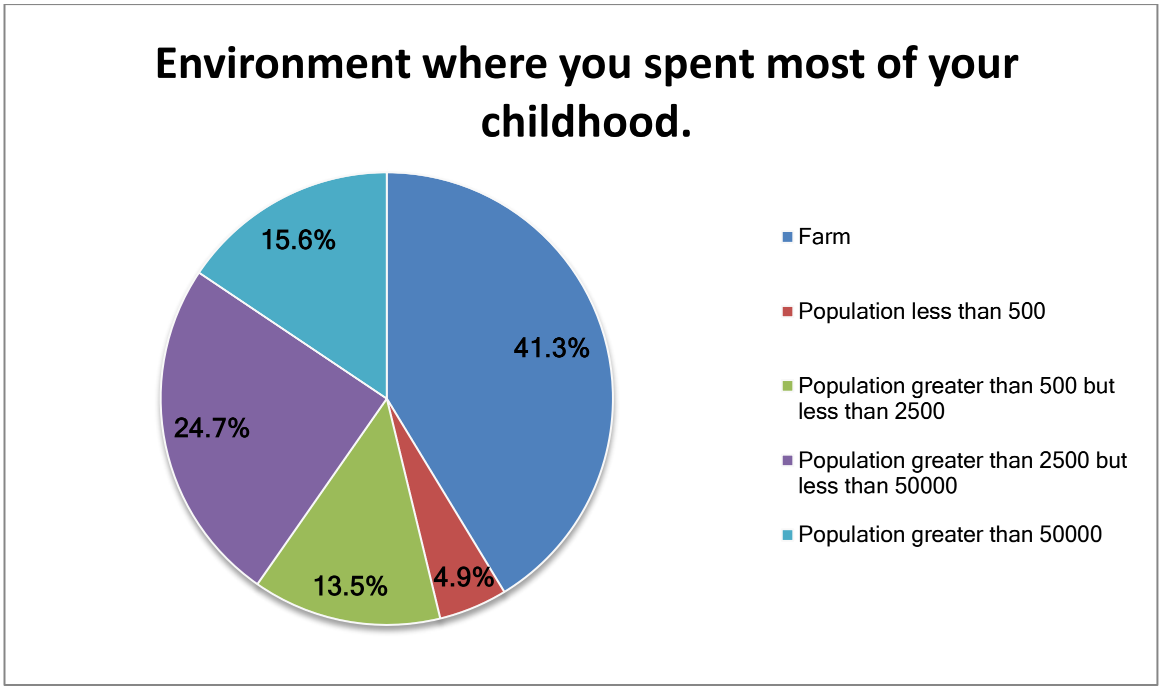
Figure 4.1 Ethnicity of sample



Environment of childhood

A little over 40% of the participants stated that they grew up in a farm environment. Approximately 5% of the participants stated they grew up in a rural area with a population of less than 500 while 13.5% of the participants grew up in small towns with a population between 500 and 2500. Approximately quarter of the total survey participants grew up in large towns and semi urban areas with a population between 2500 and 50000. Finally the percentage of participants who stated they grew up in urban metro city was 15%. The results are shown in Figure 4.2 below

Figure 4.2 Environment of childhood of sample



Work experience in agricultural workplaces

In this category survey participants' were asked if they had prior work experience either working on a farm or in other agricultural workplaces. Their responses are recorded in Table 4.6

Table 4.6
Experience working in agricultural work environment

Do you have experience working in agriculture or agricultural related environment?		
Answer Options	Response Percent	Response Count
No	24.4%	247
Yes	75.6%	765
Total (n)	100%	1012

More than 75% of the students stated that they had prior experience in agriculture or agricultural environment. This is not unexpected because 85% of the students who participated in this study either grew up in a rural area or in a small town.

Survey participants' were then asked to qualify their work experience level in an agricultural environment. The results are shown in Table 4.7:

Table 4.7
Amount of work experience in agricultural work environment

What experience do you have working in an agricultural environment?						
Answer Options	Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience	n
Number of responses	158	140	128	220	287	933

To understand the nature of prior agricultural experience, participants were asked if they had any experience in managing safety or quality in an agricultural work environment. The summary data of safety experience are shown below in Table 4.8 and summary data of quality experience are shown in Table 4.9.

Table 4.8
Experience managing safety in agricultural work environment

What experience do you have with the management of safety in an agricultural work environment?						
Answer Options	Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience	n
Number of responses	231	119	206	262	115	933

Table 4.9
Experience managing quality in agricultural work environment

What experience do you have with the management of quality in an agricultural work environment?						
Answer Options	Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience	n
Number of responses	224	130	207	243	123	927

Out of the 933 participants who reported their experience managing safety in agricultural environments, 40.4% participants claimed somewhat high or high experience, while 37.5% of participants claimed low or somewhat low experience. Similarly, out of the 927 participants who reported their experience managing quality in agricultural environments, 39.4% participants claimed somewhat high or high experience, while 38.1% participants claimed low or somewhat low experience.

Awareness and importance of safety and quality in agricultural work places

This section consists of summary data of participants' responses to statements pertaining to level of awareness and importance of safety management and quality management in the field of agriculture.

Table 4.10 summarizes the level of awareness of 930 participants regarding managing safety in agricultural environments while Table 4.11 summarizes the level of awareness of participants' regarding managing quality in agricultural environments.

Out of the 930 participants who reported their level of awareness of management of safety in agriculture, 62.9 % participants claimed they were fairly aware or very aware, while

22.2% of the participants claimed they were fairly unaware or very unaware aware of management of safety in agriculture.

Similarly, out of the 930 participants who reported their level of awareness of management of quality in agriculture, 56.9 % participants claimed they were fairly aware or very aware, while 24.8% of the participants claimed they were fairly unaware or very unaware aware of management of quality in agriculture.

Table 4.10

Level of awareness- management of safety in agriculture

How would you rate your level of awareness regarding the management of safety within the field of agriculture?						
Answer Options	Very unaware	Fairly unaware	Neither aware or unaware	Fairly aware	Very aware	n
Number of Responses	93	114	138	408	177	930

Table 4.11

Level of awareness- management of quality in agriculture

How would you rate your level of awareness regarding the management of quality within the field of agriculture?						
Answer Options	Very unaware	Fairly unaware	Neither aware or unaware	Fairly aware	Very aware	n
Number of responses	100	131	169	382	148	930

Table 4.12 summarizes the perception of 929 participants regarding the importance of safety in agricultural environments while Table 4.13 summarizes the perception of participants' regarding the importance of quality in agricultural environments.

Out of the 929 participants who reported their safety perception, 96.1% participants perceived safety as important or very important in agricultural industry, while only 1% of the participants perceived safety as not at all important or not very important in agricultural industry.

Similarly, out of the 929 participants who reported their quality perception, 96.2% participants perceived quality as important or very important in agricultural industry, while only 1% of the participants perceived quality as not at all important or not very important in agricultural industry.

Table 4.12
Safety perception of participants

How important is it to follow safety work practices in the agricultural industry?						
Answer Options	Not at all important	Not very important	Neither important or not	Important	Very important	N
Number of responses	4	6	26	216	677	929

Table 4.13
Quality perception of participants

How important is it to follow established quality management practices in the agricultural industry?						
Answer Options	Not at all important	Not very important	Neither important or not	Important	Very important	n
Number of responses	4	7	24	295	599	929

Survey data for each of the statements in this section show that the majority of pre-professionals (96%) perceived safety management and quality management as important to very important in the field of agriculture. This finding is consistent with the work of Steinberg (2007), who studied risk-taking in adolescence from the behavioral science perspective. Steinberg (2007) states that systematic research does not support the common myth that young adults' risky behavior is due to their ignorance and delusions of invulnerability. It seems the same phenomenon is true for pre-professional in agriculture.

The present study found that the level of awareness of pre-professionals on how safety and quality are managed in the field of agriculture is lower than their perception of importance of safety and quality. This may be due to the fact that the majority of these pre-professionals do not have any formal instruction in safety and quality management principles.

This study also suggests that while pre-professionals perceive the importance of safety and quality, they do not feel as though they have the level of knowledge needed to work in the field of agriculture.

Interaction between safety and quality

The next section of the survey consisted of only one statement with multiple sub-statements. Survey participants were asked how quality management systems could help reduce the occurrence of some of the most common hazards in agricultural work places. A rating of 1 represented No Impact and a rating of 5 represented High Impact. The participants' responses and the number of participants who answered each of the 12 parts are summarized in Table 4.14.

Table 4.14
Safety and quality interaction

Please rate the potential impact of quality management systems on the reduction of safety hazards from the item listed.						
Answer Options	Low or no impact	Fairly low impact	Neither high nor low impact	Fairly high impact	High impact	n
Tractor rollovers	22	55	119	400	326	922
Injuries caused by a fall	24	110	186	387	214	921
Catching clothing on a power take off (PTO)	15	56	105	380	362	918
Electrocution hazards	13	45	132	396	335	921
Pesticide exposure or spills	7	23	102	355	433	920
Contact with anhydrous ammonia	6	24	93	339	456	918
Suffocation hazards in a grain bin or wagon	12	46	109	340	410	917
Fires hazards	12	44	155	425	280	916
Injuries resulting from animals	26	114	215	366	194	915
Air quality in confined building	12	62	149	379	316	918
Gases from manure pits or silos	19	70	158	368	304	919
Health problems resulting from grain, dust or mold	12	65	158	386	298	919

Out of the approximately 920 participants who reported their perception of impact of quality management systems on safety hazards, 76.6% of the participants percieved fairly high impact or high impact. Only 8.1% of the participants percieved low or no impact or fairly low impact of quality management systems on safety hazards

Of the 12 safety hazards the three safety harards with the **highest percentatge of partcipants** rating of impact of quality management systems are i) contact with anhydrous ammonia (86.6%) ii) pesticide exposure or spills (85.6%) and iii) suffocation hazards in a grain bin or wagon (81.8%).

Similarly, the three safety harards with the **lowest percentatge of partcipants** rating of impact of quality management systems on safety hazards are i) injuries resulting from animals (61.2%) ii) injuries caused by a fall (65.35) and iii) gases from manure pits of silos (73.1%).

Factor analysis

Factor analysis is a statistical data reduction technique used to further characterize correlations among observed variables in terms of fewer unobserved variables. This analysis has the advantages of reducing the number of variables by combining two or more variables into a single factor and identifying the groups of inter-related variables, to understand how they are related with each other (Bryman & Cramer, 2009).

In order to more succinctly describe the variability of pre-professional perceptions on how quality management systems could impact the reduction of safety hazards, and safety incidents a factor analysis and principle component analysis was conducted. Out of the 1017 total participants, 922 responded to the statements measuring the impact of quality management systems on reduction of safety hazards. Among these 922 responses, some were only partially completed.

Similarly, out of the 1017 total participants, 918 responded to the statements measuring the impact of quality management systems on reduction of safety incidents. Among these 918 responses some were only partially completed.

To account for the missing participant ratings, a data imputation strategy was used. Multiple imputations (MI) are one of the most common methods for general purpose handling of missing data in multivariate analysis (Allison, 1999). According to Allison (1999), MI can be used with any kind of data as long as the data missing is random. The missing data in the in the survey response of this study was observed to be random with no noticeable pattern and hence the MI technique was used.

To make sure the response data were not altered significantly as a result of MI, a comparison of descriptive statistics of the pre-imputation and the post-imputation data sets was conducted and no significant changes were noticed. The imputed data set was then analyzed using factor analysis and principle component analysis (PCA).

The purpose of factor analysis was to reduce the number of variables. This decision on the reduction of variables was guided by Kaiser's retention criterion, which retains factors with Eigenvalues greater than one (Bryman & Cramer, 2009). To accomplish this, all pair-wise correlation coefficients were calculated among the variables.

The correlation matrix for the variables measuring quality management systems on safety hazards is shown in table 4.15 and the correlation matrix for the variables measuring quality management systems on safety incidents is shown in table 4.16

Table 4.15

Correlation matrix: Impact of quality management systems on safety hazards

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	1											
X_2	0.4270	1										
X_3	0.5986	0.4917	1									
X_4	0.541	0.4722	0.569	1								
X_5	0.3392	0.3729	0.4042	0.4939	1							
X_6	0.4141	0.3262	0.4879	0.5093	0.6562	1						
X_7	0.5324	0.3928	0.5618	0.5563	0.4943	0.5972	1					
X_8	0.4067	0.4396	0.3943	0.5819	0.4946	0.4823	0.5818	1				
X_9	0.4276	0.4904	0.386	0.4511	0.3421	0.3206	0.406	0.5491	1			
X_{10}	0.3224	0.3467	0.2674	0.4734	0.535	0.4997	0.4339	0.586	0.4921	1		
X_{11}	0.3914	0.3919	0.3708	0.4826	0.5069	0.5005	0.4913	0.5529	0.5239	0.7386	1	
X_{12}	0.3114	0.4206	0.3493	0.4447	0.509	0.4625	0.4376	0.5348	0.4585	0.6596	0.6349	1

n=922 X_1 = Tractors; X_2 = Injuries by fall; X_3 = PTO; X_4 = Electrocution; X_5 = Pesticide; X_6 = Ammonia; X_7 = Suffocation; X_8 = Fires; X_9 = Animals; X_{10} = Air quality; X_{11} = Gases; X_{12} = Grain dust mold

Table 4.16

Correlation matrix: Impact of quality management systems on safety incidents

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	1											
X_2	0.6212	1										
X_3	0.6500	0.6160	1									
X_4	0.5458	0.5734	0.6726	1								
X_5	0.4095	0.4023	0.5444	0.6035	1							
X_6	0.4438	0.4209	0.5474	0.6196	0.8179	1						
X_7	0.5039	0.5047	0.6149	0.6040	0.6225	0.6619	1					
X_8	0.4857	0.5419	0.5252	0.6302	0.5484	0.5667	0.6350	1				
X_9	0.5181	0.5667	0.5200	0.5114	0.4560	0.4657	0.5340	0.5743	1			
X_{10}	0.4455	0.4416	0.4803	0.5614	0.6581	0.6195	0.5881	0.6283	0.5520	1		
X_{11}	0.4625	0.4587	0.4877	0.5589	0.6533	0.6236	0.6194	0.6175	0.5622	0.8128	1	
X_{12}	0.4272	0.4833	0.4884	0.5537	0.6130	0.5881	0.6333	0.6393	0.5685	0.7652	0.7766	1

n=918 X_1 = Tractors; X_2 = Injuries by fall; X_3 = PTO; X_4 = Electrocution; X_5 = Pesticide; X_6 = Ammonia; X_7 = Suffocation; X_8 = Fires; X_9 = Animals; X_{10} = Air quality; X_{11} = Gases; X_{12} = Grain dust mold

Two factors met the Kaiser criterion; however the factor loading values, which represent the correlations between the common factor and input variables, showed a higher value for one factor when compared to the other factor (Bryman & Cramer, 2009). Table 4.17 shows the factor pattern of pre-professional perceptions on the impact of quality management systems on reduction of safety hazards.

Table 4.17
Factor Pattern: quality management systems on safety hazards

	Factor1	Factor2
Tractors	0.6200	0.3555
Injuries by fall	0.5949	0.1551
PTO	0.6466	0.4305
Electrocution	0.7348	0.1874
Pesticide	0.6876	-0.0879
Ammonia	0.7049	0.0335
Suffocation	0.7280	0.1944
Fires	0.7458	-0.0836
Animals	0.6376	-0.0365
Air quality	0.7323	-0.4309
Gases	0.7533	-0.3057
Grain dust mold	0.6982	-0.2894

Similarly the factor pattern of pre-professional perceptions on the impact of quality management systems on reduction of safety incidents shown in Table 4.18 also had a higher value for one factor when compared to the other factor.

Table 4.18

Factor Pattern: quality management systems on safety incidents

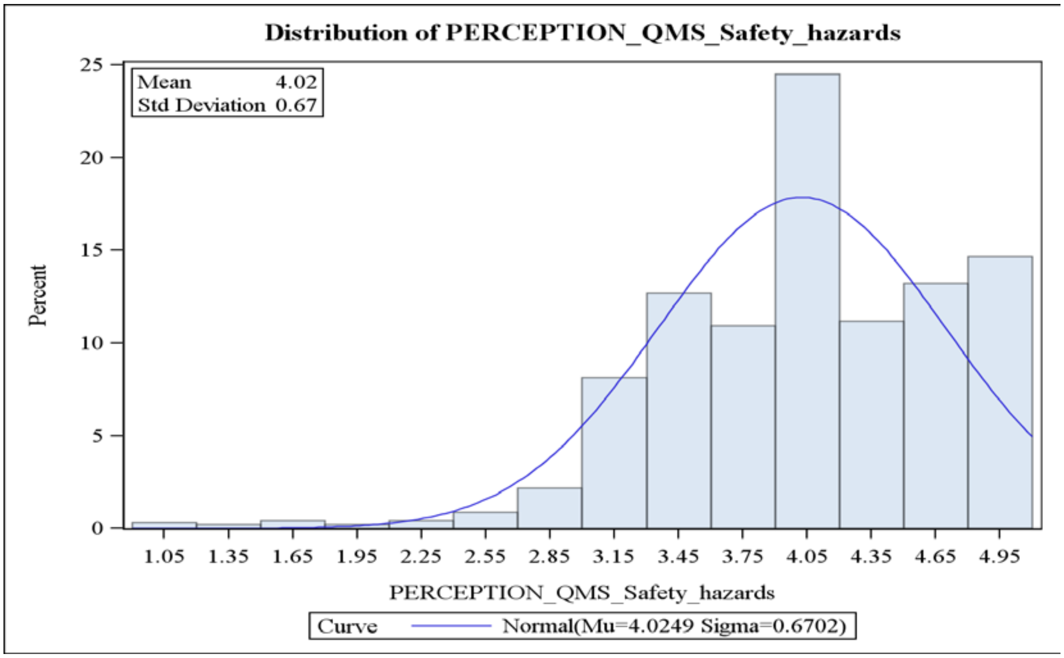
	Factor1	Factor2
Tractors	0.6579	0.3737
Injuries by fall	0.6719	0.3742
PTO	0.7390	0.3386
Electrocution	0.7732	0.1597
Pesticide	0.7817	-0.2446
Ammonia	0.7851	-0.1842
Suffocation	0.7858	0.0065
Fires	0.7684	0.0182
Animals	0.6933	0.1311
Air quality	0.8072	-0.2910
Gases	0.8166	-0.2770
Grain dust mold	0.8007	-0.2300

The high correlation between the input variables listed in table 4.17 and the common factor (factor one), led to the decision to aggregate those input variables into one universal factor. The common factor would represent the measure of pre-professionals perception of impact of quality management systems on reduction of safety hazards. A new parameter was created in the data set called “Quality on safety hazards”. The value of this parameter is the average of students’ rating for each of the 12 sub-statements measuring the impact of quality management systems on reduction of safety hazards.

Likewise the high correlation between the input variables listed in table 4.18 and the common factor, led to the decision to aggregate those input variables into one universal factor. The common factor would represent the measure of pre-professionals perception of impact of quality management systems on reduction of safety incidents. A new parameter was created in the data set called “Quality on safety incidents”. The value of this parameter is the average of students’ rating for each of the 12 sub-statements measuring the impact of quality management systems on reduction of safety incidents.

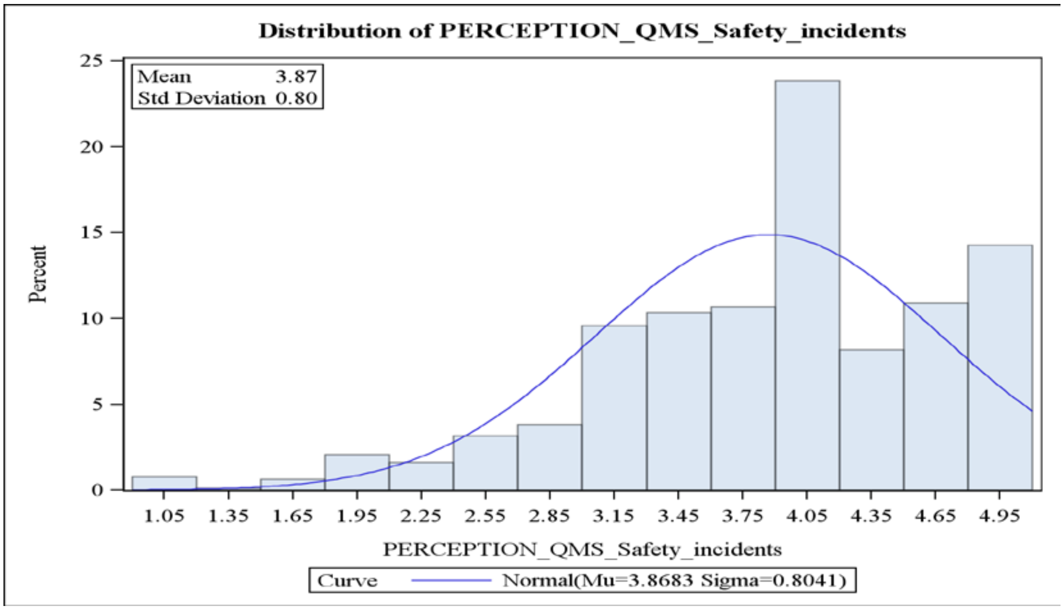
The distribution of the parameter “Quality on safety hazards” was approximately normal with a mean of 4.0248 and standard deviation of 0.67 as shown in figure 4.3.

Figure 4.3: Distribution of impact of quality management systems on reduction of safety hazards



The distribution of the parameter “Quality on safety incidents” was approximately normal with a mean of 3.8683 and standard deviation of 0.8041 as shown in figure 4.4.

Figure 4.4: Distribution of impact of quality management systems on reduction of safety incidents



Both parameters, "Quality on safety hazards" and "Quality on safety incidents", were calculated with large data sets n=922 and n=918 respectively. Hence, using the Central Limit Theorem (CLT) the distributions of both of these parameters were determined to be approximately normal (Rice, 2007).

Out of the 922 students who recorded their perception on the impact of quality management systems in reduction of safety hazards, 3.2% students perceived fairly low impact or no impact, 26.3% students perceived neither high nor low impact and 70.5% students perceived fairly high or high impact.

Likewise out of the 918 students who recorded their perception on the impact of quality management systems in reduction of safety incidents, 12.1% students perceived fairly low impact or no impact, 34.7% students perceived neither high nor low impact and 53.2% students perceived fairly high or high impact.

Statistical analysis to test hypothesis-1

To test hypothesis-1, an Analysis of Variance (ANOVA) and F-test was conducted. This analysis tested whether the perception of pre-professionals varied by age group. The results from the analysis of "Quality on safety hazards" parameter are shown in the Table 4.19. A p-value of 0.2111 indicates that there is no significant difference in the perception of pre-professionals on the impact of quality management systems on safety hazards, based on their age group. The conclusion was a failure to reject the null hypothesis that pre-professionals in different age groups would view the interaction of quality and safety hazards differently.

Further evidence of a lack of difference was noted in the value of the coefficient of determination (r^2). The value for r^2 =0.006345 indicates that only 0.6% of the variability in perceptions of quality on safety hazards can be explained by the change in age group variable.

The results from the analysis of "Quality on safety incidents" parameter are shown in the Table 4.20. The resulting p-value of this analysis was 0.0502, slightly greater than α =0.05 for the 95% significance level criteria. Although the p-level is near 0.05 in the "Quality on safety incidents" variable, the evidence is not convincing enough to reject the null hypothesis of a difference between age groups in how the interaction between quality and safety incidents were viewed.

Also a lack of difference was noted in the value of the coefficient of determination (r^2). The value for r^2 =0.01032 indicates that only 1.0% of the variability in perceptions of quality on safety incidents can be explained by the change in age group variable.

Statistical analysis to test hypothesis-2

To test hypothesis-2, a two way T-test was conducted. This analysis tested whether the perception of pre-professionals varied by gender. Since there were only two groups: males and females, a t-test was used instead of ANOVA, which was used to test the other 3 hypotheses for differences in more than 2 groups of data (Bryman & Cramer, 2009).

The results of this test on the "Quality on safety hazards" parameter are available in Table 4.19. A p-value of less than 0.001 indicates that there is a statistically significant difference between the perceptions of male and female pre-professionals in how they perceive the importance of quality management on safety hazards. Therefore, the null hypothesis is rejected.

The results of this test on the "Quality on safety incidents" parameter are shown in Table 4.20. A p-value of 0.0113 ($<\alpha = 0.05$) indicates that there is a statistically significant difference between the perceptions of male and female pre-professionals in how they perceive the importance of quality management on safety incidents. This provides evidence to reject the null hypothesis of no difference in the role gender plays in quality and safety incident interactions.

Statistical analysis to test hypothesis-3

To test hypothesis-3, Analysis of Variance (ANOVA) and F-test were conducted. This analysis tested whether the perception of pre-professionals varied by academic classification.

The results of this test on the "Quality on safety hazards" parameter are available in Table 4.19. A p-value of 0.1938 indicates that there is no significant difference in the perception of pre-professionals on the impact of quality management systems on safety hazards, based on their academic classification. In this case, we fail to reject the null hypothesis.

Further evidence of lack of difference was noted in the value of the coefficient of determination (r^2). The value for $r^2 = 0.006593$ indicates that only 0.6% of the variability in perceptions of quality on safety hazards can be explained by the change in academic classification variable.

The results of this test on the “Quality on safety incidents” parameter are available in Table 4.19. A p-value of 0.1561 indicates that there is no significant difference in the perception of pre-professionals on the impact of quality management systems on safety incidents, based on their academic classification. In this case, the conclusion is to fail to reject the null hypothesis.

Further evidence of lack of difference was noted in the value of the coefficient of determination (r^2). The value for r^2 =0.007240 indicates that only 0.7% of the variability in perceptions of quality on safety incidents can be explained by the change in academic classification variable.

Table 4.19
Summary of hypotheses testing quality management systems on safety hazards

Hypothesis	Analysis	p-value	r^2	Conclusion
No difference based on Age group	ANOVA	0.2111	0.00635	Fail to reject
No difference based on Gender	t-Test	<0.0001	NA	Reject
No difference based on Classification	ANOVA	0.1938	0.00659	Fail to reject
No difference based on Environment of Childhood	ANOVA	0.4689	0.00498	Fail to reject

Table 4.20
Summary of hypotheses testing quality management systems on safety incidents

Hypothesis	Analysis	p-value	r^2	Conclusion
No difference based on Age group	ANOVA	0.0502	0.01032	Fail to reject
No difference based on Gender	t-Test	0.0113	NA	Reject
No difference based on Classification	ANOVA	0.1561	0.00724	Fail to reject
No difference based on Environment of Childhood	ANOVA	0.0724	0.01099	Fail to reject

Statistical analysis to test hypothesis-4

To test hypothesis-4, Analysis of Variance (ANOVA) and F-test were conducted. This analysis tested whether the perception of pre-professionals varied based on where they spent most of their childhood (farm, town or large city).

The results of this test on the “Quality on safety hazards” parameter are available in Table 4.19 above. A p-value of 0.4689 indicates that there is no significant difference in the perception of pre-professionals on the impact of quality management systems on safety incidents, based on where they spent most of their childhood. For this reason, the conclusion is to fail to reject the null hypothesis.

Further evidence of lack of difference was noted in the value of the coefficient of determination (r^2). The value for $r^2 = 0.004982$ indicates that only 0.4% of the variability in perceptions of quality on safety hazards can be explained by the change in environment of childhood variable.

The results of this test on the “Quality on safety incidents” parameter are shown in Table 4.20 above. A p-value of 0.0724 indicates that there is no significant difference in the perception of pre-professionals on the impact of quality management systems on safety incidents, based on where they spent most of their childhood.

Further evidence of lack of difference was noted in the value of the coefficient of determination (r^2). The value for $r^2 = 0.01099$ indicates that only 1.0% of the variability in perceptions of quality on safety incidents can be explained by the change in environment of childhood variable.

To increase clarity and reduce noise as a result of multiple groups, hypothesis-4 was re-tested by regrouping the location where the pre-professionals spent most of their childhood. The regrouping details are shown in Table 4.21.

Table 4.21
Grouping - environment of childhood

Environment of Childhood	Grouping
Farm	Farm
Population less than 500	Farm
Population greater than 500 but less than 2500	Small Town
Population greater than 2500 but less than 50000	Small Town
Population greater than 50000	Metro City

Hypothesis-4 an was retested using Analysis of Variance (ANOVA) and F-test on the "Quality on safety hazard" parameter, resulting in a p-value of 0.9819 and r^2 =0.000188 implying no significant difference in the perception of pre-professionals on the impact of quality on safety hazards based on regrouped location where they spent most of their childhood was found.

Similarly, when hypothesis-4 was retested using Analysis of Variance (ANOVA) and an F-test on the "Quality on safety incident" parameter, a p-value of 0.1894 and r^2 =0.005203 was obtained, implying no significant difference in the perception of pre-professionals on the impact of quality on safety incidents based on regrouped location where they spent most of their childhood was found.

CHAPTER 5. DISCUSSION, CONCLUSIONS AND RECOMMENDATION

Discussion

The purpose of this study was to investigate the perception of safety and quality in the minds of pre-professionals, who are currently enrolled in the College of Agriculture and Life Sciences. Data collected for this study was done using a survey instrument, modified from a previous instrument validated by Schwab and Freeman (2002) was able to answer all research questions conclusively.

The first research question asked whether the students rating of safety and quality concerns differed based on the age group of students. This study failed to demonstrate a statistically significant difference in perception of safety and quality interaction based on age group. Previous research by Salminen (2004) concluded that young workers have a higher risk of injury than older workers, would suggest that there should be some difference in the perception of safety and quality based on age group. One reason for the lack of difference in perception based on age group could be due to the fact that 91% of the participants were 22 years of age or younger and only a small percentage (about 9%) of participants were distributed in other age groups. Previous literature defined young workers as 25 years or younger of age. Based on this definition, 97% of the undergraduate students who participated in this study could be classified as young workers as they are 25 years or younger and there is no previous research that studied the distribution of the risk perception of young workers 18 to 25 years of age. Assuming the lack of previous research is due to the fact that young workers between 18 and 25 years have similar risk profiles, then the finding in this research study are consistent with what is known thus far in the scientific literature.

The second research question asked if the perceptions of safety and quality by students differed based on the gender of the student. This study demonstrated a statistically significant difference in perception of safety and quality interaction based on gender. Data from this study show that female participants had a stronger perception of the integrative nature of safety and quality than male participants. Byrnes et al. (1999) conducted a meta-analysis of 150 studies in which risk-taking tendencies of male and female participants were compared. Byrnes et al (1999) suggested that female perceptions of risk were significantly different from that of males. Generally, females perceive risk at a higher level than males. These higher levels of risk perception by females as documented in previous literature could also suggest that females perceive factors mitigating these risks at higher level than males. This could possible explain why female students rated quality management to impact safety higher than male students as found in this study. Also in the case of safety and quality, the data suggest that they may see the interaction of the two as components that impact the risk of a workplace environment.

The third research question was concerned with the students rating of safety and quality integrations based on classification (freshman, sophomore, junior and senior) of the student. This study failed to demonstrate a statistically significant difference in the perception of safety and quality interaction based on classification. Research studies in diverse fields suggest that there is a difference in behavior based on grade or class rank. For example Robb and Sharpe (2009) in their study of college students' credit card behavior found that graduate students, juniors and seniors were more likely to carry a balance on their credit card than sophomores and freshmen. Also among debt carriers, graduate students and seniors had the highest debt levels as compared to students in other levels. Robb and Sharpe (2009) study suggests some "class rank" effects in credit card behavior.

In a study of sexual behavior, contraception, and risk among college students Siegel et al (1999) concluded that sexual behavior among college students differs across the four years, with percentage of students who had intercourse rose steadily from freshman to seniors. Since no previous study documented safety or quality perceptions by academic classification, the findings in this study are noteworthy, as they do not align with the findings of Robb and Sharpe (2009) and Siegel et al. (1999). If the students' perception of quality management impacting safety risk is analogous to their financial and health risk perceptions, then it is surprising that there was no class rank effect observed in this research study. The lack of class rank effect on students' perceptions suggests that students pick up limited information that might inform additional safety and quality perceptions even after going through the entire agriculturally based curriculum in the College of Agriculture and Life Sciences.

Finally, this study failed to demonstrate a statistically significant difference in perception of safety and quality interaction based on environment where the participant spent their childhood. This finding is consistent with the conclusions of Davidson et al (2013) concerning the usage of off road vehicles. Davidson et al (2013) concluded that even though there is a difference in the usage of off road vehicles based on urban-rural status, there is very little difference in helmet use by riders in urban versus -rural locations. In other words, there is little evidence of differences in risk perception and behavior based solely on urban or rural upbringing. It appears the same is true in the interaction of safety and quality.

Conclusion

Human factors such as employee perceptions play a vital role in the success of safety and quality programs in the work environment. Although recent study has documented a strong positive correlation between employee perceptions of quality and occupational safety risk in agricultural work environment (Mosher et al., 2012); very little is known about agricultural college students perceptions of safety and quality. While college students have some safety knowledge from classroom and life experiences, their exposure to the principles of quality management is very limited. Hence, college students may not be aware that the two concepts are associated. Furthermore, no comprehensive study has been completed on how pre-professional students perceive the interaction between quality and safety. This study investigated the perceptions of pre-professional students in College of Agriculture and Life Sciences at Iowa State University, regarding the impact of quality management systems on safety incidents and hazards. Also, this study analyzed how these perceptions vary based on key demographic characteristics such as gender, age group, academic classification and environment of childhood.

The most popular method of measuring perceptions of human subjects such as safety climate is by the use of survey questionnaire. Since there were no survey instruments that measured both safety and quality perceptions, this study developed a survey questionnaire from a previously validated safety climate instrument. The development of the questionnaire measuring both safety and quality attributes from the aforementioned safety climate survey instrument involved a multi-step process that included literature review, pilot testing, fine-tuning and validation. This study was a preliminary attempt at understanding the interaction of agricultural quality and safety perceptions of university pre-professionals, future research can explore the use of other methodologies and instruments to gain further in-depth knowledge into the interactions of safety and quality perceptions of pre-professionals.

This study established empirical evidence that pre-professionals in the College of Agriculture and Life Sciences at Iowa State University perceive a strong correlation between safety and quality. This study further supports the work of Mosher (2011) and Mosher et al

(2012), who found a strong positive correlation between employees’ perceptions of safety and quality in an agricultural work environment.

This study demonstrated a statistically significant difference in perception of safety and quality interaction based on gender. Female participants had a higher perception of interactions between quality and safety hazards and safety incidents than did male participants. These findings are consistent with previous literature. Byrnes et al (1999) conducted a meta-analysis of 150 studies in which risk-taking tendencies of male and female participants were compared. Byrnes et al (1999) study suggested female perceptions of risk were significantly different from that of males. Generally, females perceive risk at a higher level than males. In the case of safety and quality, the data suggest that they may see the interaction of the two as a component that mitigates the risk of a workplace environment.

This study failed to demonstrate a statistically significant difference in perception of safety and quality interaction based on age group. Salminen (2004) conducted a global literature review and concluded that young workers have a higher risk of injury than older workers. This would suggest that there should be some difference in the perception of safety and quality based on age group. Interestingly, the finding in this study is contrary to conventional wisdom. The reason for the lack of difference in perception based on age group could be due to the fact that 91% of the participants were 22 years of age or younger and only a small percentage (only about 9%) of participants were distributed in other age groups. Previous literature define young workers as 25 years or younger of age. Almost 97% of the undergraduate students who participated in this study were 25 years or younger, hence no significant difference was observed in their perception of safety and quality. Further research is required to study the impact of age on perception of safety and quality interactions, with greater care on differentiating between "young" college-aged students as compared with "older" college-aged students.

This study failed to demonstrate a statistically significant difference in the perception of safety hazards and incidents and quality interaction based on classification. Research studies in diverse fields suggest that there is a difference in behavior based on grade or class rank. For example Robb and Sharpe (2009) in their study of college student's credit card behavior found that graduate students, juniors and seniors were more likely to carry a balance than sophomore and freshman. Also among debt carriers, graduate students and seniors had the highest debt levels as compared to students in other levels. Robb and Sharpe (2009) study suggests some "class rank" effects in credit card behavior.

In a study of sexual behavior, contraception, and risk among college students Siegel et al (2009) concluded that sexual behavior among college students differs across the 4 years. Hence, it is surprising to note that there is no significant difference observed in safety and quality perception by grade classification as found in this study. This finding suggests that students gain limited additional information to use in forming their safety and quality perceptions even after going through the entire agricultural curriculum in the college. More research is needed to enhance the students' exposure to advanced topics in safety and quality.

Finally this study failed to demonstrate a statistically significant difference in perception of safety and quality interaction based on environment where the participant spent their childhood. This finding is consistent with the conclusions of Davison et al. (2013). Davidson et al. (2013) concluded that even though there is a difference in the usage of off road vehicles based on urban-rural status yet there is very little difference in helmet use between urban-rural locations. The data suggest that risk perceptions do not differ between those who live in rural versus urban areas. It appears the same is true regarding perceptions on the interaction of safety and quality.

The findings of this study also align with previous studies by Crowe (1995) and Blair et al. (2004) that investigated safety beliefs, safety values and practices among Midwestern college students. Blair et al. (2004) and Crowe (1995) studies reported that gender has a significant effect on safety beliefs, safety values and practices with female students more safety conscious than male students. The gender difference implies that young females are more likely to execute safe behavior than their male counterparts. A possible explanation to the findings of this study that showed female students perceived quality management systems impacting safety hazards and incidents differently than male students.

In addition to gender, Blair et al.'s (2004) study reported that age of students has a significant impact on their safety beliefs, safety values and practices. However, Crowe's (1995) did not consider age as a factor in his study. It is interesting that the results of this study showed that age of student does not impact their perception of quality management systems impacting safety hazards and incidents. One reason for this may be because of the small age differences in the primarily college-aged students in the sample.

Another interesting finding of this study showed that student's academic classification had no impact on perception of quality management systems in mitigating safety hazards and incidents. Blair et al. (2004) also reported that students' academic standing has no significant effect on their safety beliefs and safety behavior. However Crowe's (1995) study reported a significant effect of academic classification on students' safety values.

Finally both Blair et al. (2004) and Crowe (1995) reported that geographic region of student had no significant effect on their safety beliefs, safety values and practices. Similarly, the results of this study also showed that the geographic region where the student spent their childhood does not impact their perception of quality management systems in impacting safety hazards and incidents.

Recommendations for future research

- This study was limited to pre-professionals enrolled in College of Agriculture and Life Sciences at Iowa State University. Further research can extend the scope of the study to other college and universities.
- Comparative analysis of employees' perceptions and pre-professionals' perceptions of safety and quality in agricultural work environments.
- This study utilized survey instruments to measure the interactions between safety and quality perceptions of pre-professionals. Further research can explore non-survey, qualitative techniques to measure pre-professional perceptions.
- This study demonstrates that although agricultural students have an awareness of safety and how it interacts with quality, the opportunity to further develop student knowledge on how the two interact is needed. The importance of the interaction of agricultural safety and quality must be a part of future agricultural curriculum development so that new agricultural professional for the 21st century can be prepared to meet the needs and challenges of the field of agriculture.

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APPENDIX

Survey Instrument used in this study to investigate the perception of safety and quality concerns of pre-professional agricultural students. This survey was delivered electronically using SurveyMonkey.

Integration of Quality & Safety in Agricultural Workplaces

1. Are you 18 years of age or older?

- Yes
- No

Integration of Quality & Safety in Agricultural Workplaces

2. To what age group do you belong?

- 18-20 yrs
- 21-22 yrs
- 23-24 yrs
- 24-26 yrs
- 26 yrs and above

3. What is your gender?

- Female
- Male

4. What is your grade classification?

- Freshman
- Sophomore
- Junior
- Senior

5. Please describe the environment where you spent most of your childhood.

- Farm
- Population less than 500
- Population greater than 500 but less than 2500
- Population greater than 2500 but less than 50000
- Population greater than 50000

6. Please describe your ethnicity

- White
- Hispanic or Latino
- Black or African American
- Native American or American Indian
- Asian / Pacific Islander
- Other

Integration of Quality & Safety in Agricultural Workplaces

7. Do you have experience working in agriculture or agricultural related environment?

- No
- Yes

Integration of Quality & Safety in Agricultural Workplaces

8. What experience do you have working in an agricultural environment?

Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience

9. What experience do you have with the management of safety in an agricultural work environment?

Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience

10. What experience do you have with the management of quality in an agricultural work environment?

Low experience	Somewhat low experience	Neither high nor low	Somewhat high experience	High experience

11. How would you rate your level of awareness regarding the management of safety within the field of agriculture?

Very unaware	Fairly unaware	Neither aware or unaware	Fairly aware	Very aware

12. How would you rate your level of awareness regarding the management of quality within the field of agriculture?

Very unaware	Fairly unaware	Neither aware or unaware	Fairly aware	Very aware

13. How important is it to follow safety work practices in the agricultural industry?

Not at all important	Not very important	Neither important or not	Important	Very important

14. How important is it to follow established quality management practices in the agricultural industry?

Not at all important	Not very important	Neither important or not	Important	Very important

Integration of Quality & Safety in Agricultural Workplaces

15. Please rate the potential impact of quality management systems on the reduction of safety hazards from the item listed. A rating of 1 represents No Impact and a rating of 5 represents High Impact.

	Low or no impact	Fairly low impact	Neither high nor low impact	Fairly high impact	High impact
Tractor rollovers					
Injuries caused by a fall					
Catching clothing on a power take off (PTO)					
Electrocution hazards					
Pesticide exposure or spills					
Contact with anhydrous ammonia					
Suffocation hazards in a grain bin or wagon					
Fires hazards					
Injuries resulting from animals					
Air quality in confined building					
Gases from manure pits or silos					
Health problems resulting from grain, dust or mold					

16. Please indicate your level of agreement with the following statements.

	Strongly Disagree	Somewhat Disagree	Unaware	Somewhat agree	Strong agree
The concept of quality in the agricultural industry is as simple and clear as it is in a manufacturing environment					
Young adults and students in the agricultural industry are not well versed in quality management concepts					
Occupational safety levels in agricultural industries impact the level of quality practices within a workplace					
Age and experience impact quality practices					

17. How might quality management systems reduce the risk of the following safety incidents in an agricultural environment?

	Little or no reduction	Small reduction	No change	Moderate reduction	Significant reduction
Tractor rollovers					
Injuries caused by a fall					
Getting clothing caught in PTO unit					
Electrocution					
Pesticide exposure or spills					
Injuries with hydrous ammonia					
Suffocation in a grain bin or wagon					
Fire Hazards					
Injuries from animals					
Health problems caused from air in confined building					
Gases from manure pits or silos					
Health problems caused by grain, dust or mold					