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Approaching Safety through Quality: Factors Influencing College Student Perceptions

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Abstract
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Keywords
College students, Quality management, Worker safety

Disciplines
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The relationship between safety and quality has always been of interest to both industry practitioners as well as academic scholars. Numerous past studies have suggested a strong theoretical and empirical link between safety and quality. Dumas (1987), one of the earliest contributors, suggested that safety is a dimension of quality because elimination of defects would also include the elimination of unsafe work practices. Minter (1991) affirmed that "safety is covered as one of the various requirements of performing a quality job" because doing a job correctly would also mean doing it safely. After observing strong similarities between the management of safety and quality, Warrack and Sinha (1999) concluded that quality management systems such as ISO 9000 could also be used to ensure high workplace safety performance. Herrero et al. (2002) empirically demonstrated that actions designed to improve aspects of quality and production also improved occupational safety. Using Maslow's hierarchy of needs, Das et al. (2008a) suggested that safety is a basic need and that higher organizational goals, such as quality improvement, can only be achieved once the basic needs of safety have been met.

The agricultural industry is often ranked as one of the most hazardous industries in the U.S. due to the high rate of work-related injuries and deaths (BLS, 2014). Myers (2006) suggested that when addressing the risks of agricultural work environments, safety pro-

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fessionals must focus on eliminating risks rather than simply controlling them. Accordingly, Hurburgh and Lawrence (2003) suggested that quality management is a potential tool for eliminating and managing some agricultural safety risks as well as some of the conditions that promote safety risks. Despite the strong evidence linking safety and quality in agriculture, the agribusiness industry has not widely adopted and applied quality management practices as a potential method of mitigating safety hazards and incidents (Mosher et al., 2012; Das et al., 2008).

To date, limited studies have explored the interaction between agricultural safety and quality. Riedel and Field (2011) and Freeman et al. (1998) observed that poor-quality grain has a higher likelihood of resulting in increased grain engulfment hazards, thus implying a direct connection between safety and quality. Suutarinen (2004) found that injuries were more probable in agricultural workplaces with inferior management practices. Although the study did not find any conclusive evidence, Suutarinen (2004) suggested that improvements in quality of operations would not only increase efficiency and reduce delays but also reduce risk factors for injuries.

An important link between safety and quality that has not received much attention involves human factors such as employee perceptions, knowledge, skill, participation, and motivation. Mosher et al., (2012) measured the connections between employee safety and quality perceptions in an agribusiness work environment and found a strong, positive relationship. Ramaswamy and Mosher (2015) measured the safety and quality perceptions of agricultural college students. In their study, Ramaswamy and Mosher (2015) found a strong, positive link between student perceptions of safety and quality despite the students' limited formal training in either discipline. Ramaswamy and Mosher (2015) also investigated the link between demographic factors and student perceptions. Student perceptions of quality and safety in agricultural work environments varied by gender, but no significant differences in perceptions were observed based on the students' academic classification, age group, field of study, or childhood environment (Ramaswamy and Mosher, 2015).

Although it is clear that both agricultural students and workers see associations between safety and quality (Mosher et al., 2012; Ramaswamy and Mosher, 2015), the basis of these perceptions is unknown. One hypothesis is that previous knowledge, work experience, and awareness of the concepts of safety and quality could explain a portion of the association. Accordingly, this study examined how students' awareness of safety and quality management, work experience in safety and quality management, and perceived importance of safety and quality influenced their views on the potential influence of quality management practices in mitigating safety hazards and safety incidents.

Literature Review

Employees in agricultural industries face unique occupational hazards and risks not present in other industries (Hard and Myers, 2006). These hazards are especially relevant to young workers. According to Wright et al. (2013), one young worker dies in an agriculture-related incident every three days, and 45 young workers are injured each day in the U.S. Researchers believe that injuries and fatalities in agricultural settings can be prevented (Kingman and Field, 2013; Wright et al., 2013), but previous methods of intervention have shown mixed results (DeRoo and Rautiainen, 2000; Hale et al., 2010). A high proportion of employees working in agricultural industries are less than 25 years old

(Hendricks et al., 2005). A review of the research literature showed that young workers are highly vulnerable to workplace injuries and fatalities across all industries (Salminen, 2004). Limited experience and lack of awareness have been stated as the primary reasons for the high injury risks among young workers (Thamrin et al., 2010).

Role of Human Factors in Safety and Quality

Organizational factors such as quality climate, management support, and employee participation are critical for the implementation and success of quality management systems (Hietschold et al., 2014; Mantura, 2008; Mosher, 2011; Mosher et al., 2012). Analogous to safety climate, quality climate is thought to be a primary factor influencing employee perceptions of quality (Luria, 2008; Mosher et al., 2013). Furthermore, several researchers have found factors such as employee knowledge, education, and training to be critical components for the successful implementation of quality management practices (Das et al., 2008b; Hietschold et al., 2014; Nair, 2006; Rahman and Bullock, 2005). Hietschold et al. (2014) reviewed the research literature in quality management and suggested that behavioral and human elements are more important for the success of quality management systems than technical aspects such as process control tools and techniques.

A limited number of studies in the agricultural industry have investigated the association of human elements with safety and quality management. Kingman and Field (2005) studied grain engulfments using fault tree analysis and concluded that quality of grain, improper handling and storage management, safety knowledge and safety compliance of employees were contributing factors in engulfment events. Mosher et al. (2012) investigated the relationship between safety climate and quality climate as perceived by grain elevators employees. Mosher et al. (2012) found a significant positive relationship between organizational safety climate and employee quality decisions and between organizational quality climate and employee safety decisions.

Link between Organizational and Individual Factors

While organizational factors are believed to have the strongest influence on the safety and quality perceptions of employees, recent research suggests the importance of individual elements as mediating factors in these relationships (Kongsvik et al., 2010; Vinodkumar and Bhasi, 2010). Griffin and Neal (2000) proposed and tested a model in which they suggested that the impact of organizational factors on safety outcomes is mediated by individual factors such as employee awareness, knowledge, and motivation. Christian et al., (2009) examined the antecedents of safety outcomes and concluded that safety knowledge and safety motivation were strongly related to safety performance behavior, which in turn was associated with safety outcomes such as accidents and injury. Vinodkumar and Bhasi (2010) analyzed employee perceptions of safety management practices and employees' self-reported safety knowledge, motivation, compliance, and participation. The researchers concluded that safety knowledge and motivation were key mediating factors between safety management and safety outcomes such as accidents and near misses.

Researchers have also suggested the importance of individual factors such as employee knowledge, involvement, and motivation in the success of quality management systems. Mosher et al. (2013) suggested that fundamental organizational change efforts such as quality management will be successful only when employees' cognitive resistance to beneficial changes is resolved. To realize the benefits of organizational change, employees must fully participate in all quality improvement activities, acquire new knowledge,

and feel a sense of accomplishment (Zhang et al., 2000; Chrusciel and Field, 2003). Employee involvement will overcome some of the cognitive hurdles, positively impacting the successful implementation of quality management systems (Das et al., 2008b). Ahire et al. (1996) proposed that knowledge of quality concepts, tools, and techniques is essential for employees to understand and resolve quality issues. Das et al. (2008b) suggested that employees are a valuable resource in implementing quality systems, and therefore their training and development should be viewed as a necessary investment. Training empowers employees and is thus a pre-condition for a higher degree of employee involvement, which is a key factor for the success of quality management systems within a firm (Hietschold et al., 2014).

College students represent new employees in the agricultural industry. They are a population of interest because of their high vulnerability to injury and fatality in the agricultural industry (Hard and Myers, 2006). Previous research suggests that effective quality management practices have the potential to mitigate and eliminate agricultural work hazards, lowering the risk of injury and fatality (Hurburgh and Lawrence, 2003; Kingman and Field, 2005). However, no comprehensive study exists on the factors influencing the interaction of agricultural quality and safety perceptions of college students. Very little is known about the influence of factors such as student knowledge and perceived importance of safety and quality and amount of work experience on student perceptions. This research, along with Ramaswamy and Mosher (2015), extends the study of employee-related factors in agricultural work places by Mosher et al. (2012) to future young workers in collegiate settings.

Methodology

This study evaluated how college students' self-reported scores on awareness, skill, and importance of safety and quality influenced their perceptions of the role quality management in mitigating safety hazards and incidents in the agricultural workplace. Data for the study were collected using a survey instrument designed based on Dillman's (2007) tailored design method. The survey was administered electronically to 4,035 students enrolled in the College of Agriculture and Life Sciences (CALS) at a large Midwestern land grant university in the fall of 2013.

The survey instrument was adapted by Ramaswamy and Mosher (2015) based on two previous studies. The instrument used by Schwab and Freeman (2002) in examining safety perceptions of students in the Agricultural Systems Technology (AST) major at Iowa State University from 1993 through 2001 was modified for the study. Second, the survey instrument used by Mosher et al. (2012) in examining the interaction between safety and quality climate in the agricultural industry was also used in the survey design. Further discussion of survey development and validation is provided by Ramaswamy and Mosher (2015).

Student awareness of safety and quality in agricultural workplaces was assessed using student responses to two items on the survey. Students responded on a five-point scale ranging from "unaware" (1) to "fully aware" (5). Similarly, student work experience and student experience managing safety and quality in agricultural workplaces were assessed using three items on the survey. Students reported their safety, quality, and overall work experience on a five-point scale ranging from "low experience" (1) to "high experience" (5). Students were asked to report their perceived importance of safety and quality in ag-

riculture with two items on the survey on a five-point scale that ranged from "not at all important" (1) to "very important" (5).

Twelve items on the survey assessed student perceptions of the mitigation potential of quality management practices on safety hazards and incidents. An example of a survey question is as follows: "Please rate the potential impact of quality management systems on the reduction of safety hazards in tractor rollovers." Students were asked to rate the impact of quality management practices on safety hazards using a five-point scale ranging from "low or no impact" (1) to "high impact" (5). Likewise, students reported the perceived mitigation potential of quality management practices on safety incidents using a five-point scale ranging from "little or no reduction" (1) to "significant reduction" (5). An example of a survey question from this section is "How might quality management systems reduce the risk of tractor rollovers?" Because the resulting values were highly inter-correlated, the mean ratings for the 12 items were used as the students' perceptions of the mitigation potential of quality management practices on safety hazards and incidents.

The project was guided by research questions that evaluated the relationships between each explanatory variable and student perceptions of the potential of quality management practices to reduce agricultural workplace safety hazards and incidents. The relationships investigated included:

1. Student work experience in agriculture and in agricultural safety and quality.
2. Level of student awareness of agricultural safety and quality.
3. Student perceptions of the importance of safety and quality in agricultural workplaces.

Data analysis was conducted using SAS version 9.3. Descriptive and inferential statistics were used to test the research questions in this study. Statistical operations performed included multivariate correlation, univariate regression, and multiple regression.

Results and Discussion

The survey was sent to 4035 undergraduate students enrolled in the College of Agriculture and Life Sciences at a large Midwestern land grant institution in the U.S. Responses were received from 1017 students, with 886 usable for data analysis, reflecting a 22% response rate. Typically, the average response rate for internet-based surveys is 25%, much lower than that of mail surveys (Dillman, 2007; Manfreda et al., 2008; Millar and Dillman, 2011). The distribution of participants by gender was 60% female and 40% male. The distribution of students based on grade classification was 28% freshman, 20.1% sophomore, 25.3% juniors, and 25.3% seniors. The distribution of participants was comparable to the population distribution based on age, major, and grade classification. A greater proportion of female students participated in the study than male students. Although there were more female respondents, the distribution still aligned well enough with the proportion of females in the larger population to facilitate valid data analysis. For this reason, it was determined that the distribution of participants who responded to the survey was representative of the undergraduate student population in the College of Agriculture and Life Sciences.

Fifty-four percent of participants stated that they had high or somewhat high overall work experience in an agricultural environment, as shown in table 1. However, only 40% stated they had somewhat high or high experience specifically managing safety and quali-

Table 1. Distribution of participants' agricultural, safety, and quality work experience.

	Number of Participants for Each Response (Percentages in Parentheses)					
	Low Experience	Somewhat Low Experience	Neither High nor Low Experience	Somewhat High Experience	High Experience	Total
Amount of ag work experience	158 (16.9%)	140 (15.0%)	128 (13.7%)	220 (23.6%)	287 (30.8%)	933 (100%)
Safety work experience	231 (24.8%)	119 (12.8%)	206 (22.1%)	262 (28.0%)	115 (12.3%)	933 (100%
Quality work experience	224 (24.2%)	130 (14.0%)	207 (22.3%)	243 (26.2%)	123 (13.3%)	927 (100%)

ty in an agricultural work environment, as shown in table 2. More than half of the participants stated they were fairly aware or very aware of safety and quality practices in agricultural work environments (table 2). However, 96% of participants perceived safety as important or very important in the agricultural industry, while an equal number of participants perceived quality as important or very important in agricultural workplaces (table 3).

Student perceptions of the role of quality management practices in mitigating agricultural safety hazards and safety incidents were measured using the students' responses to a set of 12 items on the survey. Questions were based on the role of quality management practices for specific hazards (i.e., tractors) and on the resulting safety incidents. Because the responses were closely inter-correlated, the mean scores from the twelve "hazard" questions were combined into one variable, and the mean scores from the "incident" questions were combined into a second variable. These items served as the dependent variables in the regression model. Factor analysis confirmed the validity of this decision. Means, standard deviations, and correlations of all the variables are reported in table 4.

To fully understand the factors influencing student perceptions of the influence of quality management practices on safety hazards and safety incidents in agricultural workplaces, multivariate analysis was conducted. The students' safety, quality, and agricultural work experience was measured along with their ratings of their awareness and the importance of safety and quality. These items were independent variables in the regression model.

Table 2. Distribution of participants' awareness of safety and quality management practices.

	Number of Participants for Each Response (Percentages in Parentheses)					
	Very Unaware	Fairly Unaware	Neither Aware nor Unaware	Fairly Aware	Very Aware	Total
Safety awareness	93 (10.0%)	114 (12.3%)	138 (14.8%)	408 (43.9%)	177 (19.0%)	930 (100%)
Quality awareness	100 (10.8%)	131 (14.1%)	169 (18.2%)	382 (41.1%)	148 (15.9%)	930 (100%)

Table 3. Distribution of participants' perceived importance of safety and quality management practices.

	Number of Participants for Each Response (Percentages in Parentheses)					
	Not at All Important	Not Important	Neither Important nor Not	Important	Very Important	Total
Safety importance	4 (0.4%)	6 (0.7%)	26 (2.8%)	216 (23.2%)	677 (72.9%)	929 (100%)
Quality importance	4 (0.4%)	7 (0.7%)	24 (2.6%)	295 (31.8%)	599 (64.5%)	929 (100%)

Table 4. Mean, standard deviation, and correlation matrix.[a]

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. QMS on safety hazards	4.01	0.67								
2. QMS on safety incidents	3.85	0.81	0.54*							
3. Amount of ag work experience	3.37	1.47	-0.01	-0.06						
4. Safety work experience	2.90	1.37	0.05	-0.01	0.83*					
5. Quality work experience	2.91	1.38	0.05	-0.01	0.82*	0.87*				
6. Safety awareness	3.51	1.21	0.08	0.03	0.71*	0.73*	0.72*			
7. Quality awareness	3.38	1.21	0.06	0.03	0.71*	0.70*	0.74*	0.84*		
8. Safety importance	4.68	0.60	0.22*	0.17*	0.05	0.07	0.09	0.16*	0.14*	
9. Quality importance	4.60	0.61	0.26*	0.22*	0.05	0.06	0.09	0.13*	0.15*	0.66*

[a] $N = 886$; asterisk (*) indicates $p < 0.05$; QMS = influence of quality management systems.

Stepwise regression was used first to identify independent variables that explained a significant portion of the variance in the model. Next, the variables identified in the stepwise process were held constant, and hierarchical linear regression was used by adding one independent variable in each iterative step. The amount of variance explained by each additional variable in the model was determined. To determine if the variance explained was significant to the model, an F-test was used. The model with all independent variables (the full model) was compared with the model that included only the significant independent variables (the reduced model). In addition, the coefficient of determination (R^2), coefficient of variation, and Akaike's information criterion (AIC) were used to evaluate the regression models.

Because multicollinearity due to highly correlated variables was a potential issue, the variable inflation factor (VIF) was calculated for each independent variable. The VIF values for the independent variables in the reduced model ranged from 1.7 to 3.4, while the range of VIF values for the full model ranged from 1.7 to 5.2. Because the values of VIF were well below the critical value of 10, it was determined that multicollinearity was not an issue for these data (O'Brien, 2007).

Results for the reduced model and full model that best predicted student perceptions of the influence of quality management practices on agricultural safety hazards are shown in table 5. Table 6 shows results for the reduced and full models that best predicted student perceptions of the influence of quality management practices on agricultural incidents.

The first research question investigated if agricultural work experience influenced students' perceptions regarding the mitigating potential of quality management practices on agricultural safety hazards and safety incidents. Descriptive analysis showed the correlation between student work experience and perceptions of safety and quality to be weak

Table 5. Regression of influence of quality management practices on agricultural safety hazards.[a]

	Reduced Model				Full Model			
Variable	β	SE	t-Value	VIF	β	SE	t-Value	VIF
Amount of work experience	-0.15*	0.03	-2.45	3.45	-0.15*	0.03	-2.37	3.83
Safety experience	0.1	0.03	1.61	3.66	0.08	0.04	1.10	5.28
Safety awareness	0.07	0.03	1.44	2.37	0.09	0.04	1.40	4.02
Safety importance	0.08	0.05	1.91	1.80	0.08	0.05	1.89	1.80
Quality importance	0.20*	0.05	4.53	1.78	0.20*	0.05	4.55	1.79
Quality experience	-	-	-	-	0.04	0.04	0.49	5.22
Quality awareness	-	-	-	-	-0.04	0.04	-0.55	4.06
R^2	0.08				0.08			
Coefficient of variation	16.04				16.06			
AIC	-774.19				-770.63			

[a] Asterisk (*) indicates $p < 0.05$; all regression coefficients are standardized.

Table 6. Regression of influence of quality management practices on agricultural safety incidents.[a]

	Reduced Model				Full Model			
Variable	β	SE	t-Value	VIF	β	SE	t-Value	VIF
Amount of work experience	-0.20*	0.03	-3.30	3.45	-0.20*	0.04	-3.20	3.83
Safety experience	0.08	0.04	1.32	3.66	0.08	0.04	1.12	5.28
Safety awareness	0.07	0.03	1.56	2.37	0.06	0.04	0.88	4.02
Safety importance	0.04	0.06	0.92	1.80	0.04	0.06	0.93	1.80
Quality importance	0.19*	0.06	4.34	1.78	0.19*	0.06	4.27	1.79
Quality experience	-	-	-	-	0.00	0.04	-0.08	5.22
Quality awareness	-	-	-	-	0.03	0.04	0.50	4.06
R^2	0.06				0.06			
Coefficient of variation	20.46				20.48			
AIC	-415.44				-411.69			

[a] Asterisk (*) indicates $p < 0.05$; all regression coefficients are standardized.

and non-significant. However, the regression coefficient for student work experience was found to be significant in predicting student perceptions of the mitigating potential of quality management practices on safety hazards and safety incidents. The negative value for the correlation and regression coefficient indicates that students with higher amounts of work experience perceived lesser impact of quality management systems on safety hazards and incidents than students with lower or no work experience. In addition, student safety and quality management experience in an agricultural work environment were not significant in predicting student perceptions of the mitigating potential of quality management practices on safety hazards and incidents.

The negative relationship between agricultural work experience and student perceptions was unexpected. Khanzode et al. (2012), in their comprehensive review of the research literature, suggested that injury risks are high in initial periods of employment and decrease as workers gain more work experience. Furthermore, Vinodkumar and Bhasi (2009) and Zhou et al. (2008) stated that work experience is positively correlated to safety knowledge and thus influences employee perceptions. The negative relationship between student work experience and perceptions in this study implies that safety intervention programs must also include experienced employees and not focus only on new employees.

The second research question investigated if student safety and quality awareness influenced student perceptions of the mitigation potential of quality management practices on safety hazards and quality management practices on safety incidents. Results from the regression and correlation analysis showed that students' awareness of safety and quality management practices was not significant in influencing their perceptions. This finding does not align with the findings of Griffin and Neal (2000) and Neal et al. (2000), who stated that personal factors such as employee knowledge and awareness influenced employee safety perceptions.

An important finding of this study was that students' safety and quality awareness were significantly correlated with their work experience, but students' perceived importance of safety and quality had a very weak correlation with their work experience. This suggests that students' general understanding of the importance of safety and quality is not a result of their prior work experience.

The third research question investigated if students' opinions of the importance of agricultural safety and quality influenced their perceptions of the mitigation potential of quality management practices to reduce agricultural safety hazards and safety incidents.

Table 7. Results of hypotheses testing.

Variable	Independent Variable vs. Perceived Impact of Quality Management Practices on Safety Incidents and Hazards	Safety Hazards, $N = 886$ (p-value)	Safety Incidents, $N = 886$ (p-value)	Result ($\alpha = 0.05$)
1	Amount of work experience	0.02	<0.01	Significant
2	Safety management experience	0.27	0.27	Not-significant
3	Quality management experience	0.63	0.93	Not-significant
4	Awareness of safety	0.16	0.38	Not-significant
5	Awareness of quality	0.58	0.62	Not-significant
6	Safety importance	0.06	0.35	Not-significant
7	Quality importance	<0.001	<0.001	Significant

The results showed that students' perceptions of the importance of quality was a significant predictor of their perceptions of the mitigation potential of quality management practices. Students' perceptions of the importance of safety were found to be significantly correlated to their perceptions of the influence of quality on mitigating safety hazards and incidents but were not significant in the regression analysis. This finding suggests that students who perceive quality as important may be more likely to use quality to mitigate safety hazards and incidents. A higher motivation toward quality and ensuring that tasks are performed the right way ensures higher productivity as well as higher safety performance (Manzella, 1997), and it seems that the students perceived this relationship in a similar way. Table 7 shows the results of the hypothesis testing for the research questions.

Conclusion

Human factors have been identified as the critical elements for the success of both safety and quality programs, but the interaction of human perceptions across many areas related to safety and quality is not well understood. An important finding of this study is that perceptions about the importance of quality significantly impacted student perceptions of the mitigation potential of quality management practices on safety hazards and safety incidents. A challenge for educators is to find a way to emphasize and increase student perceptions of the importance of quality management in safety-sensitive environments.

Conventional wisdom suggests that greater awareness of safety and quality practices and a greater amount of work experience leads to a higher perceived importance of safety and quality. However, in this study, students' awareness and work experience were not significantly correlated with their perceptions of the importance of safety and quality in agriculture. Further research can investigate predictive factors for each of the explanatory variables used in this study. Generally, most students in the College of Agriculture and Life Sciences are not required to take any formal coursework in safety or quality. Moreover, with on-the-job learning also having a limited impact on student perceptions of the importance of safety and quality, these findings support the case for reviewing how safety and quality are currently taught in the agricultural curriculum.

The findings of this study must be viewed within the context of the study's limitations. First, data were collected from one group of students at one university in one region of the U.S. Another limitation of this research was that subjects volunteered for the study. This introduced potential for selection bias by which participants who felt strongly about

safety and quality could have responded to the survey at a higher rate than those who were indifferent to the topic. Extending this study to students at other colleges and universities would substantially strengthen the conclusions of this study.

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References

Ahire, S. L., Golhar, D. Y., & Waller, M. A. (1996). Development and validation of TQM implementation constructs. *Decision Sci., 27*(1), 23-56. http://dx.doi.org/ 10.1111/j.1540-5915.1996.tb00842.x

BLS. (2014). Employer-reported workplace injuries and illness: 2013. Washington, DC: Bureau of Labor Statistics. Retrieved from www.bls.gov/news.release/pdf/osh.pdf

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *J. Appl. Psychol., 94*(5), 1103-1127. http://dx.doi.org/10.1037/a0016172

Chrusciel, D., & Field, D. W. (2003). From critical success factors into criteria for performance excellence: An organizational change strategy. *J. Ind. Tech., 19*(4), 1-11.

Das, A., Pagell, M., Behm, M., & Veltri, A. (2008a). Toward a theory of the linkages between safety and quality. *J. Oper. Mgmt., 26*(4), 521-535. http://dx.doi.org/10.1016/j.jom.2007.06.005

Das, A., Paul, H., & Swierczek, F. W. (2008b). Developing and validating total quality management (TQM) constructs in the context of Thailand's manufacturing industry. *Benchmarking: Intl. J., 15*(1), 52-72.

DeRoo, L. A., & Rautiainen, R. H. (2000). A systematic review of farm safety interventions. *American J. Prev. Med., 18*(4), 51-62. http://dx.doi.org/10.1016/S0749-3797(00)00141-0

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method*. 2007 update with new internet, visual, and mixed-mode guide. Hoboken, NJ: John Wiley and Sons.

Dumas, R. (1987). Safety and quality: The human dimension. *Prof. Saf., 32*(12), 11-14.

Freeman, S. A., Kelley, K. W., Maier, D. E., & Field, W. E. (1998). Review of entrapments in bulk agricultural materials at commercial grain facilities. *J. Saf. Res., 29*(2), 123-134. http://dx.doi.org/10.1016/S0022-4375(98)00008-5

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *J. Occup. Health Psychol., 5*(3), 347-358. http://dx.doi.org/10.1037/1076-8998.5.3.347

Hale, A. R., Guldenmund, F. W., van Loenhout, P. L. C. H., & Oh, J. I. H. (2010). Evaluating safety management and culture interventions to improve safety: Effective intervention strategies. *Saf. Sci., 48*(8), 1026-1035. http://dx.doi.org/10.1016/j.ssci.2009.05.006

Hard, D. L., & Myers, J. R. (2006). Fatal work-related injuries in the agriculture production sector among youth in the U.S., 1992-2002. *J. Agromed., 11*(2), 57-65. http://dx.doi.org/10.1300/J096v11n02_09

Hendricks, K. J., Layne, L. A., Goldcamp, E. M., & Myers, J. R. (2005). Injuries to youth living on U.S. farms in 2001 with comparison to 1998. *J. Agromed., 10*(4), 19-26. http://dx.doi.org/10.1300/J096v10n04_05

Herrero, S. G., Saldana, M. A. M., del Campo, M. A. M., & Ritzel, D. O. (2002). From the traditional concept of safety management to safety integrated with quality. *J. Saf. Res., 33*(1), 1-20.

http://dx.doi.org/10.1016/S0022-4375(02)00008-7
Hietschold, N., Reinhardt, R., & Gurtner, S. (2014). Measuring critical success factors of TQM implementation successfully: A systematic literature review. *Intl. J. Prod. Res., 52*(21), 6254-6272. http://dx.doi.org/10.1080/00207543.2014.918288
Hurburgh, C. R., & Lawrence, J. D. (2003). The need for quality management systems. *Resource, 10*(9), 29. St. Joseph, MI: ASABE.
Khanzode, V. V., Maiti, J., & Ray, P. K. (2012). Occupational injury and accident research: A comprehensive review. *Saf. Sci., 50*(5), 1355-1367. http://dx.doi.org/10.1016/j.ssci.2011.12.015
Kingman, D. M., & Field, W. E. (2005). Using fault tree analysis to identify contributing factors to engulfment in flowing grain in on-farm grain bins. *J. Agric. Saf. Health, 11*(4), 395-405. http://dx.doi.org/10.13031/2013.19718
Kongsvik, T., Almklov, P., & Fenstad, J. (2010). Organisational safety indicators: Some conceptual considerations and a supplementary qualitative approach. *Saf. Sci., 48*(10), 1402-1411. http://dx.doi.org/10.1016/j.ssci.2010.05.016
Luria, G. (2008). Controlling for quality: Climate, leadership, and behavior. *Qual. Mgmt. J., 15*(1), 27-40.
Manfreda, K. L., Bosniak, M., Berzelak, J., Haas, I., & Vehovar, V. (2008). Web surveys versus other survey modes: A meta-analysis comparing response rates. *Intl. J. Market Res., 50*(1), 79-104.
Mantura, W. (2008). Human factors in quality management. *Human Factors and Ergonomics in Manuf., 18*(5), 565-579. http://dx.doi.org/10.1002/hfm.20125
Manzella, J. C. (1997). Achieving safety performance excellence through TQM. *Prof. Saf., 42*(5), 26-28.
Millar, M. M., & Dillman, D. A. (2011). Improving response to web and mixed-mode surveys. *Public Opinion Qtly., 75*(2), 249-269. http://dx.doi.org/10.1093/poq/nfr003
Minter, S. G. (1991). Quality and safety: Unocal's winning combination. *Occup. Hazards, 53*(10), 47-51.
Mosher, G. A. (2011). Measurement and analysis of the relationship between employee perceptions and safety and quality decision-making in the country grain elevator. PhD diss. Ames, IA: Iowa State University.
Mosher, G. A., Keren, N., Freeman, S. A., & Hurburgh Jr, C. R. (2012). Management of safety and quality and the relationship with employee decisions in country grain elevators. *J. Agric. Saf. Health, 18*(3), 195. http://dx.doi.org/10.13031/2013.41957
Mosher, G. A., Keren, N., & Hurburgh Jr, C. R. (2013). Employee trust and its influence on quality climate at two administration levels. *J. Tech. Mgmt. Appl. Eng., 29*(2), 2-12.
Myers, M. L. (2006). Emerging technologies and the safety and health of farming people. *J. Agric. Saf. Health, 12*(3), 179-180. http://dx.doi.org/10.13031/2013.21231
Nair, A. (2006). Meta-analysis of the relationship between quality management practices and firm performance: Implications for quality management theory development. *J. Oper. Mgmt., 24*(6), 948-975. http://dx.doi.org/10.1016/j.jom.2005.11.005
Neal, A., Griffin, M. A., & Hart, P. M. (2000). The impact of organizational climate on safety climate and individual behavior. *Saf. Sci., 34*(1-3), 99-109. http://dx.doi.org/10.1016/S0925-7535(00)00008-4
O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Qual. Quantity, 41*(5), 673-690. http://dx.doi.org/10.1007/s11135-006-9018-6
Rahman, S. U., & Bullock, P. (2005). Soft TQM, hard TQM, and organisational performance relationships: An empirical investigation. *Omega, 33*(1), 73-83. http://dx.doi.org/10.1016/j.omega.2004.03.008
Ramaswamy, S. K., & Mosher, G. A. (2015). Perceptions of agricultural college students on the relationship between quality and safety in agricultural work environments. *J. Agric. Health Saf., 21*(1), 47-64. http://dx.doi.org/10.13031/jash.21.10804
Riedel, S., & Field, W. (2011). Summary of over 800 grain storage and handling-related entrapments and suffocations documented in the U.S. between 1970 and 2010. In *Proc. XXXIV CIOSTA-CIGR*

V Conf. Vienna, Austria: University of Natural Resources and Applied Life Sciences.
Salminen, S. (2004). Have young workers more injuries than older ones? An international literature review. *J. Saf. Res., 35*(5), 513-521. http://dx.doi.org/10.1016/j.jsr.2004.08.005
Schwab, C. V., & Freeman, S. A. (2002). Pre-professionals' perceptions of agricultural hazards and practiced safety behaviors. NIFS Paper No. 2002-02. 2002. National Institute for Farm Safety.
Suutarinen, J. (2004). Management as a risk factor for farm injuries. *J. Agric. Saf. Health, 10*(1), 39-50. http://dx.doi.org/10.13031/2013.15673
Thamrin, Y., Pisaniello, D., & Stewart, S. (2010). Time trends and predictive factors for safety perceptions among incoming South Australian university students. *J. Saf. Res., 41*(1), 59-63. http://dx.doi.org/10.1016/j.jsr.2009.11.003
Vinodkumar, M. N., & Bhasi, M. (2009). Safety climate factors and its relationship with accidents and personal attributes in the chemical industry. *Saf. Sci., 47*(5), 659-667. http://dx.doi.org/10.1016/j.ssci.2008.09.004
Vinodkumar, M. N., & Bhasi, M. (2010). Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Anal. Prev., 42*(6), 2082-2093. http://dx.doi.org/10.1016/j.aap.2010.06.021
Warrack, B. J., & Sinha, M. N. (1999). Integrating safety and quality: Building to achieve excellence in the workplace. *Total Qual. Mgmt., 10*(4-5), S779-S785. http://dx.doi.org/10.1080/0954412997802
Wright, S., Marlenga, B., & Lee, B. C. (2013). Childhood agricultural injuries: An update for clinicians. *Current Problems in Pediatric and Adolescent Health Care, 43*(2), 8-32. http://dx.doi.org/10.1016/j.cppeds.2012.08.002
Zhang, Z., Waszink, A., & Wijngaard, J. (2000). An instrument for measuring TQM implementation for Chinese manufacturing companies. *Intl. J. Qual. Reliability Mgmt., 17*(7), 730-755. http://dx.doi.org/10.1108/02656710010315247
Zhou, Q., Fang, D., & Wang, X. (2008). A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience. *Saf. Sci., 46*(10), 1406-1419. http://dx.doi.org/10.1016/j.ssci.2007.10.005