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Measurement and analysis of the relationship between employee perceptions and safety and quality decision-making in the country grain elevator

by

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Major: Industrial and Agricultural Technology

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This dissertation is dedicated to

my grandmothers, the late Hazel M. Gibson Craig and LaVon M. Watson Roepke, who taught me to appreciate life's small daily pleasures

and

my grandfathers, the late Arlo F Craig, Sr. and Albert W. Roepke, who believed that an optimistic viewpoint and a sense of humor can improve any situation

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CHAPTER 1. INTRODUCTION TO RESEARCH

Human factors play an important, but often overlooked, role in the management of safety and quality in the work environment. Both safety and quality programs in the workplace depend on team-oriented employees who can spot potential issues and correct them on the floor or the line (Das, Pagell, Behm, and Veltri, 2008). Researchers and experts from several academic areas have noted the importance of positive employee involvement in the success of quality management systems and possible linkages between quality and safety (Brown, 1996; Das et al., 2008; Goetsch, 2008; Hurburgh & Hansen, 2002; Salazar, 1989; Voigt, 2005).

One human factor which is believed to influence employee safety and quality of work is trust. Although linkages between safety outcomes and employee trust have been explored by some researchers (Conchie & Donald, 2008; Conchie, Donald, & Taylor, 2006; Cox, Jones, & Collinson, 2006), few have examined the linkages between occupational safety and quality programs or the relationship between employee trust and the implementation of quality programs (Das et al., 2008). Furthermore, the success of both workplace safety and quality programs are dependent on the decisions employees make on the job (Zohar & Erev, 2007). For this reason, an increased understanding of factors influencing employee decision-making processes is an important component of occupational safety and quality management programs as well as associated employee educational intervention.

Safety hazards in agricultural production and handling represent a perennial concern for workers, management, and other agricultural professionals (Bureau of Labor Statistics, 2008). Management and supervisory personnel at commercial grain handling facilities deal with a wide variety of safety issues spanning several safety standards and guidelines. Other challenges of agricultural handling facilities include working with a large number of seasonal and temporary laborers and the intense pressure for high productivity during the busy spring and fall seasons (Brandon, 2009; Chapman & Husberg, 2008; Lehtola, Brown, & Becker, 2009). Based on the incident rate and historical patterns of both injuries and fatalities, it is well established that managing safety at a commercial grain elevator is a challenge (Laviana, 2010).

Another challenge for the commercial grain elevator is that the management of quality in agricultural commodities is changing (Hurburgh & Lawrence, 2003). Production agriculture is becoming more focused on product isolation, source verification, traceability and other differentiation processes to add value to bulk commodity crops (Miranowski, Jensen, Batres-Marques, & Ishdorj, 2004), but even without specialized markets, the quality of grain is a key consideration in its storability, marketability, and end uses (Reed, 2006). In both existing and emerging agricultural markets, management of and increased efficiencies in bulk grain handling can be facilitated through a quality management system (Laux, 2007; Laux & Hurburgh, 2010 Thakur et al., 2009). These systems have been used in manufacturing to improve efficiency and maintain high levels of quality (Bowersox, Closs, & Cooper, 2007; Das et al., 2008; Deming, 2000; Saraph, Benson, & Schroeder, 1989), but have not been widely used in bulk commodity agricultural handling (Hurburgh & Lawrence, 2003).

Laux's (2007) case study examined the effectiveness of quality management systems in a grain handling organization. While the research illustrated several key benefits of tighter management of grain quality factors in a grain elevator environment, one area which remains unexamined by researchers is how the participation of employees impacts a quality management system. Employees, their perceptions, and the management of their accumulated knowledge which result from these perceptions have been shown to be an important component of significant changes in the workplace (Chrusciel, 2004; Chrusciel & Field, 2003; Liebowitz, 1999). In the grain handling industry, quality management systems which go beyond the conventional commodity-based grades can most certainly be defined as significant change (Hurburgh & Lawrence, 2003; Laux & Hurburgh, 2010). Directing significant workplace changes involves appropriate knowledge management strategies (Chrusciel & Field, 2003).

Scholars of knowledge management posit that employee knowledge should be managed as an organizational resource (Baskerville & Dulipovici, 2006). Bjornson (2007) describes the focus of knowledge management as a way to create and transfer knowledge within an organization and notes the dynamic nature of the process. A more expansive view of organizational knowledge is defined as the information which results in routines and

processes which facilitate appropriate actions (Baskerville & Dulipovici, 2006). Employee decisions constitute a major portion of this action in both positive and negative ways. Consequently, the decision making patterns of employees have the potential to work for or against organizational quality management processes (Luning & Marcelis, 2007). The variability introduced by employee decisions is difficult to scientifically estimate or control, but this variation has the potential to substantially impact the success of the quality processes (Lunning & Marcelis, 2007).

This research will address an important element of safety and quality programs in the workplace – personnel and their interpretation of the importance of safety and quality in comparison with other organizational goals delegated to them by their supervisors and management. Safe workplaces benefit both workers and the organization (Goetsch, 2008). Quality management systems increase revenue, improve inventory management, and allow increased compliance with legal regulations (Laux, 2007). None of these improvements can be realized if employees do not make positive safety and quality-oriented decisions on the job.

PURPOSE OF RESEARCH

This project will examine the level of employee trust in two levels of administration (the immediate supervisor and the top management team) at three grain handling organizations. In addition, the project will measure the employee perceptions of the priority of safety and quality in the work environment as compared with other organizational goals. The term used in the literature to describe employee perceptions of the relative importance of safety and quality is climate (Cooper& Phillips, 2004; Zohar, 2000) and this term will be used throughout the dissertation.

The goal is to determine if the degree of employee trust and employee perceptions of quality and safety climate can predict 1) the final decision of the employee or 2) the process of decision-making in scenarios involving workplace safety (taking shortcuts) and compliance with quality processes (following orders which undermine product quality). The decision making process will involve measuring the relative priorities the employee emphasizes among four dimensions to help him or her make the final decision.

The project also examines whether the climate measures of employee trust, safety, and quality have a predictive relationship. Two measurement parameters are used to define climate (Zohar, 2000). The level of a climate describes the employee's perception of the attribute in question (trust, safety, or quality) by the employees. The mean perception score of each employee reflects the numerical value of this measurement. The strength measures the agreement employees have regarding the perception score. The standard deviations of all employee strength scores provide a numerical measure for strength, which is the level of consensus employees have concerning the level of safety climate.

Demographic characteristics have been identified as another possible factor in organizational safety attitudes and in individual safety situations (Gyekye & Salminen, 2009; Henning et al., 2009). Although demographic characteristics such as gender, age, and length of organizational service were collected as part of this research, these variables will be controlled when measuring the effect of climate measures on the model.

Using this information, more targeted and responsive educational intervention can be developed for safety and quality management programs within the country grain elevator, leading to improvements in organizational knowledge management. Improved knowledge management in turn may encourage conditions which lead to superior performance, organizational creativity, operational effectiveness, and a higher quality of products and services (Baskerville & Dulipovici, 2006).

RESEARCH QUESTIONS

The study will be guided by the following research questions:

1. Does the level of an employee's trust in the management and supervisors predict the level and strength of the employee's ratings of safety climate?
2. Does the level of employees' trust and safety climate concerning the management and supervisors predict employees' decision choice in safety decision-making tasks?
3. Does the level of employees' trust and safety climate concerning the management and supervisors predict employees' orientation to information acquisition in safety decision-making tasks?

4. Does the level of employees' trust in the management and supervisors predict the level of the employees' ratings of quality climate?

5. Does the level of employees' trust and quality climate concerning the management and supervisor predict employees' decision choice in quality decision-making tasks?

6. Does the level of employees' trust and quality climate concerning the management and supervisors predict the employees' orientation to information acquisition in quality decision-making tasks?

7. Does the level of organizational and group safety climate predict the level of organizational and group quality climate?

8. Does the level of employees' organizational and group quality climate predict employees' decision choice in safety decision-making tasks?

9. Does the level of employees' organizational and group safety climate predict employees' decision choice in quality decision-making tasks?

10. Does the level of employees' organizational and group safety climate predict employees' decision choice in safety decision-making tasks?

11. Does the organizational level and strength of safety and quality climates predict the group level of safety and quality climates?

MEASUREMENT AND METHODOLOGY

To gather information needed to answer the research questions, the methodology was completed in three parts. First, a three-part survey was conducted. Grain handling personnel from three Iowa grain handling organizations were surveyed. Using an electronic questionnaire (Survey Monkey), employees were asked about their level of trust in their supervisor and in the management at their organization. Employees were also surveyed on their perceptions of the safety and quality climates from both management and supervisory perspectives at their organizations. Two of the three instruments used in the project were previously validated (Zohar & Luria, 2005; Levin, 1999) and the third was modified from the validated safety climate instrument (Zohar & Luria, 2005).

Testing the validity of an instrument involves an assessment of how well it measures what it claims to measure. In this case, the factor in question was trust. The focus of the

validation procedure was construct validity which tested how well the instrument scales measured the constructs of credibility and consistency. This is done by examining findings across different researchers and different studies (Levin, 1999) and by factor analysis. Factor analysis is typically used for two purposes: to reduce the number of variables to a smaller set of non-redundant factors and to test the validity of research instruments (Bryman & Cramer, 2009; Agresti & Finlay, 1999).

Several steps are involved in a factor analysis. First, a correlation matrix is calculated using all of the variables measuring a specific concept. If all or nearly all correlations between variables are significant at the 0.05 level, this can be interpreted to mean the concept may be described adequately by combining several variables, lowering the number of factors entered into the final model (Bryman & Cramer, 2009). If the variables are not significantly correlated, the interpretation is that each variable measures a specific concept. Consequently, several variables cannot be combined into one factor without substantial loss of explanatory power.

Once it is determined that the existing variables exhibit a significant level of correlation, all variables in question are entered into a software program such as SPSS which will characterize the variance. Researchers are concerned with three types of variance in factor analysis: specific variance, unique variance, and error variance. Specific variance measures the variance of one specific variable and is not present in any other variable. Common variance measures the variance which is shared across the responses for more than three variables. Error variance is variation which occurs as a result of measurement and other uncontrollable errors inherent to data collection (Bryman & Cramer, 2009). Of interest to most researchers is the variance which is shared by variables, allowing the researcher to combine several variables into a smaller set of factors (Agresti & Finlay, 1999).

After the variables are entered into a software program, each variable's influence on the variance of a test is measured by extracting factors. The first factor extracted measures the most amount of variance, the second factor extracted measures the second highest amount of variance and so on. Therefore, the first few factors extracted are the most important in terms of the variance explained. The quantitative measure for variance explained by the

factors is a value called an Eigenvalue. The greater amount of variance explained by the factor, the greater the value of the Eigenvalue (Bryman & Cramer, 2009).

The next step is to determine how many factors to retain in the model. To help researchers with this task, two criteria are used: Kaiser's criterion and the scree test (Bryman & Cramer, 2009). Kaiser's criterion posits that factors with an Eigenvalue of one or greater should be retained in the model. The basis for this decision is the assumption that the variance of each entered variable has been standardized as one; therefore, a factor must explain at least the amount of variance contained in one variable. The scree test shows graphically the factors which explain the greatest amount of variance. Above the point on the plot where the Eigenvalue drops drastically is where the most influential factors lie, while the gentle slope of the remaining values illustrates the factors with less explanatory power. The factors which exhibit an Eigenvalue of one or greater and are graphically shown on the scree plot are those which are retained in the model (Bryman & Cramer, 2009; Agresti & Finlay, 1999).

Previously validated instruments were used to measure behavioral trust and safety climate. The quality climate instrument was developed based on the safety climate instrument (Zohar and Luria, 2005). The Management Behavior Climate Assessment (Levin, 1999) was used to evaluate employee trust levels in their management and their supervisor, as well as provide demographic data such as age, gender, and length of time with the organization. This instrument was developed as a behavioral measurement of trust in top tier and executive tier (supervisory) management. Levin (1999) validated the survey by testing it on 601 individuals from seven diverse organizations including manufacturing, academic, military, and government. In the resulting factor analysis, two factors were identified by Levin (1999) to explain the concept of trust: consistency and credibility. A copy of the 40 item survey is shown in Appendix A.

To measure employee perceptions of safety climate, the Organization and Group Level Safety Climate instrument (Zohar & Luria, 2005) was used. The instrument surveyed employees concerning their perceptions of two tiers: organizational level (management) and group (supervisory) level. Zohar and Luria administered the instrument to 3,952 employees from 36 manufacturing plants in several industries. Johnson (2007) further validated the

instrument with an additional 292 employees at three heavy manufacturing locations. Although both researchers (Johnson, 2007; Zohar & Luria, 2005) found evidence to support a three factor structure for a safety climate measure, both also noted high significant correlations between the factors and a substantial number of variables loading on more than one factor. Johnson (2007) and Zohar and Luria (2005) concluded the possibility of a single factor, termed global commitment or global safety priority, which could adequately explain the concept of safety climate.

Factor analysis completed for this project on the safety climate instrument had similar results to Johnson (2007) and Zohar and Luria (2005). Highly significant correlations between variables, a large number of cross-loadings, and the initial principal component analysis indicating one factor all contributed to the decision to use a single factor to describe organizational safety climate and a second single factor to describe group safety climate. A copy of the 32 item Organization and Group Level Safety Climate is shown in Appendix B.

The quality climate instrument was modified from the Organization and Group Level Safety Climate instrument (Zohar & Luria, 2005). Questionnaire items were modified slightly to better reflect quality concerns within an agricultural processing organization. Results from the instrument were similar to the safety climate instrument. Highly significant correlations between variables, substantial cross-loadings of variable items, and the identification of a single factor to explain quality climate at both the organizational and group levels led to the decision to use one factor to describe quality climate at each administration tier. The 31 item Organization and Group Level Quality Climate is displayed in Appendix C.

Trust, safety, and quality climates were assessed at two tiers – management and supervisory - based on recommendations from previous research (Zohar, 2008). While employees may have daily communication with their supervisor, the communication with management may be limited to infrequent meetings or other sporadic contacts so perceptions may be very different between tiers. Moreover, concerning safety and quality perceptions, while the management team may create and promote the daily policies and procedures, it is the supervisors that actually implement and interpret these policies on a daily basis (Zohar, 2000, 2008). The focus of this research explores which perspective plays a stronger role in the decision choices of employees.

The second portion of the study was the decision-making scenarios, with one safety scenario and one quality scenario presented to each employee in random order. Employees were provided with specific directions on completing the decision scenarios. Decision choices were presented in a matrix format as shown in Table 1 with four dimensions that were hypothesized to play a role in making the decision choice. With each decision simulation, employees read the hypothetical situation and then were presented four alternatives. Each square of the matrix (V) represents the evaluation of a given choice (C) on a given dimension (D) and a weighted numerical score (contained within V). Weighted scores were assigned by panels of experts in agricultural safety and quality on a scale from -10 to +10. Scores less than zero denote a negative evaluation and scores greater than zero designate a positive evaluation. Using the information contained within the matrix squares, employees viewed the information and then selected a decision choice. The Decision Mind™ software tracked all of the matrix squares which were viewed, how many times each were viewed, the time used by the employee to make the decision choice, and the employee's final decision. The safety and quality scenarios are shown in Appendices D and E.

Table 1. Decision Mind^{TM} Decision Simulation Matrix

	C_1	C_2	C_3	C_4
D_1	V_{11}	V_{21}	V_{31}	V_{41}
D_2	V_{12}	V_{22}	V_{32}	V_{42}
D_3	V_{13}	V_{23}	V_{33}	V_{43}
D_4	V_{14}	V_{24}	V_{34}	V_{44}

The scenarios were created based on information gathered from published literature, current events in the agricultural handling industry, and the professional opinions of experts in both agricultural safety and grain quality. Surveys and scenarios were pilot tested on a sample of individuals who had moderate levels of knowledge in agricultural safety and/or grain quality (n=12). Slight modifications were made to improve the clarity of the survey instruments and the decision scenarios as the result of the pilot tests.

The safety scenario is based on a fundamental safety issues in all work environments – failing to follow standard operating procedures (SOPs) (Keren et al., 2009; Mills, 2007). The National Safety Council (1999) has linked the act of "taking a shortcut" to occupational injuries and accidents. The safety decision scenario was written to reflect a potential shortcut opportunity in the grain handling industry. The situation is fairly common in the industry - the bridging of out of condition grain as it is being unloaded from a grain storage bin, which delays the speed of the grain flow out of the bin (Brandon, 2009; Freeman, Kelley, Maier, & Field, 1998; Kingman & Field, 2005). Following SOPs will resolve the issue, but require additional time, slowing productivity. Fixing the problem quickly presents a major engulfment hazard to the employee. The dilemma presented to the employee asks him or her to decide whether to follow safety procedures and take additional time or fix the problem quickly but with an increased risk of injury or death.

Engulfments involving bulk agricultural materials do not occur frequently, but the survival rate of victims is low (Brandon, 2009; Freeman et al., 1998; Roberts & Field, 2010). Several factors add to the danger of an engulfment situation. A lack of awareness of the danger of flowing grain, the speed total engulfment can occur, storage of wetter and more out-of-condition grains, and larger storage facilities all make a dangerous situation even more hazardous (Roberts & Field, 2010). In the past, entrapments were noted in larger numbers on farms, but recent data gathered by Purdue University has shown a shift to include more engulfment events at commercial grain elevators than previously (Brandon, 2009).

The quality scenario was based on the concept of choosing between following orders and acting in the best interest to preserve and/or maintain quality of the product. Adapted for the grain handling environment, the situation was one very familiar to both producers and commercial grain elevators in recent years – the handling and management of high moisture grain. The employee is asked to dump wet grain onto a pile with an unknown (but likely wet) moisture level. He or she knows this action will have a very negative impact on the grain's quality attributes, but the orders are very clear from management and the supervisor – accept the grain and dump it on the specified pile.

A fundamental aspect of grain preservation is to control and manage moisture very carefully (Reed, 2006). In 2008 and 2009, this basic guideline was difficult for many grain

handlers to follow. Unusual weather patterns, limited drying time, high moisture corn, and abundant harvests limited the options for preservation and storage of grains (Hurburgh & Elmore, 2009). Conventional methods were not effective when corn was coming into the grain elevator at 25% moisture rather than the more typical 14-15% (Hurburgh, Bern, & Brumm, 2008). Situations typical of the one used as the decision scenario challenged many grain handling and storage facilities to think about quality in a different way than they had previously.

<div align="center">STATISTICAL ANALYSIS</div>

A wide variety of data were collected for this dissertation. Because of this, several descriptive and inferential statistics were used for analysis. First, all manuscripts will include demographic information on the sample, which numbered 197 total participants. After sorting out duplicates and eliminating invalid entries, the sample included 178 valid responses on the climate instruments (trust, safety, and quality) and 160 for the safety decision and 158 for the quality decision respondents. Descriptive data on decision choice is presented, as well as bivariate correlation relationships between the variables.

The process used in the development of the climate measures and decision scenarios was described in detail earlier in the chapter, so discussion of them here will be brief. The instruments used to collect climate data were validated previously (Levin, 1999; Zohar & Luria, 2005); therefore, a factor analysis was performed to verify previous factor loadings (Agresti & Finlay, 1999; Bryman & Cramer, 2009). Factor analysis was also performed to verify that the sample of agricultural workers evaluated trust and safety climate in a statistically similar way to previous sample groups. The quality climate instrument was modified from the safety instrument, and its factor analysis outcome behaved in the same way as did the safety climate instrument. Based on the outcomes of the factor analysis and the properties of the data, a decision was made to use a single factor to interpret safety and quality climate at each level of administration. Trust at both management and supervisory levels were represented by two factors: consistency and credibility.

To explore relationships and determine the predictive nature of the variables, linear regression techniques were used. To study the relationship between trust and safety climates, the safety decision choice, and safety decision process, stepwise and hierarchical regression

techniques were used to evaluate the amount of variance in employee decision choice and decision-making process is explained by organizational and group level factors of trust (consistency, credibility, and relevancy) and safety climate (Bryman & Cramer, 2009). Stepwise regression was used first to identify control variables (demographic variables) and variables of interest (organizational and group trust and safety climate) which explained a significant portion of variance in the model. Next, the control variables were held constant and hierarchical linear regression was used to determine if the variables of interest explained a significant incremental amount of variance in the decision choice and decision-making process of employees. Then, models with the significant variables (the reduced model) were re-run and compared with models which included all of the variables (the complete model) to test for differences between the full and reduced models (Agresti & Finlay, 1999).

A similar procedure was used in the quality model and in the safety/quality model. For the quality model, control variables were entered into the stepwise regression model. Next, the significant control variables were held constant while variables of interest were entered, including organizational and group level trust and quality climate data. Finally, the reduced models were compared with the complete models using the coefficient of determination and F-values. In the safety/quality model, control variables were entered first, and then the safety/quality climate variables, and finally, the decision choice variables.

For all regression models, the coefficient of determination (r^2) and the F-value was computed to determine the amount of variance explained by all of the variables entered into the model. In all models, decision data were reverse coded, with positive safety and quality decisions coded as higher numbers (i.e. 3 and 4) and less positive safety and quality decisions coded as lower numbers (i.e. 1 and 2). This is the opposite of values assigned to the climate instruments, so negative relationships between the decision choice and the climate variables are expected.

ORGANIZATION OF DISSERTATION

This dissertation is written in the alternative manuscript format as defined by Iowa State University's Graduate College. Chapter one is the general introduction which outlines the basic ideas behind the research and summarizes the goals and objectives. Chapter two serves as the literature review of research used as a basis for and justification of the

dissertation research. Chapters three, four, and five are three manuscripts formatted for submission to specified journals. Chapter six is a general summary and interpretation of findings, recommendations for further research, and conclusions. Appendices include the three climate instruments (trust, safety, and quality) as well as the two decision scenarios.

REFERENCES

Agresti, A. & Finlay, B. (1999). *Statistical methods for the social sciences (3rd ed.)*. Upper Saddle River, NJ: Prentice Hall.

Baskerville, R. & Dulipovici, A. (2006). The theoretical foundations of knowledge management. *Knowledge Management Research and Practice*, 4(1), 83-105.

Bjornson, F.O. (2007). Knowledge management in software process improvement. Unpublished doctoral dissertation. Norwegian University of Science and Technology. Doctoral theses at NTNU, 2007: 152.

Bowersox, D., Closs, D., & Cooper, M.B. (2007). *Supply chain logistics management*. New York, NY: McGraw Hill.

Brandon, H. (August 4, 2009). Grain storage – deadly dangers. *Delta Farm Press*. Downloaded August 6, 2009 from: http://deltafarmpress.com/com/grain-storeage-0804/

Brown, K.A. (1996). Workplace safety: A call for research. *Journal of Operations Management*, 14(2), 157-171.

Bureau of Labor Statistics. (2008). National Census of fatal occupational injuries in 2007. United States Department of Labor: Washington, D.C. Downloaded March 16, 2009 from: http://www.bls.gov/news.release/pdf/cfoi.pdf.

Bryman, A. and Cramer, D. (2009). *Quantitative data analysis with SPSS 14, 15, and16*. New York, NY: Routledge, Taylor and Francis Group.

Chapman, L.J. & Husberg, B. (2008). Agriculture, forestry, and fishing sector. *Journal of Safety Research*, 39(2), 171-173.

Chrusciel, D. (2004). Considerations for dealing with significant organizational change. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International A65/08.

Chrusciel, D. & Field, D. (2003). From critical success factors into criteria for performance excellence – An organizational change strategy. *Journal of Industrial Technology*, 19(4).

Conchie, S.M. & Donald, I.J. (2008). The functions and development of safety-specific trust and distrust. *Safety Science*, 46(1), 92-103.

Conchie, S.M., Donald, I.J, & Taylor, P.J. (2006). Trust: Missing piece(s) in the safety puzzle. *Risk Analysis*, 26(5), 1097-1104.

Cox, S., Jones, B. & Collison, D. (2006). Trust relations in high-reliability organizations. *Risk Analysis*, 26(5), 1123-1138.

Das, A., Pagell, M., Behm, M., & Veltri, A. (2008). Toward a theory of the linkages between safety and quality. *Journal of Operations Management*, 26(4), 521-535.

Deming, W.E. (2000). *Out of the crisis*. Boston, MA: MIT/CAES.

Freeman, S.A., Kelley, K.W., Maier, D.E., & Field, W.E. (1998). Review of entrapments in bulk agricultural materials at commercial grain facilities. *Journal of Agricultural Safety and Health*, 4(2), 119-130.

Goetsch, D.L. (2008). *Occupational safety and health for technologists, engineers, and managers, 6th edition.* Upper Saddle River, NJ: Pearson/Prentice Hall.

Gyekye, S.A. & Salminen, S. (2009). Educational status and organizational safety climate: Does educational attainment influence workers' perceptions of workplace safety? *Safety Science*, 47(1), 20-28.

Henning, J.B., Stuffy, C.J., Payne, S.C., Bergman, M.E., Mannan, M.S., and Keren, N. (2009). The influence of individual differences on organizational safety attitudes. *Safety Science*, 47(1), 337-345.

Hurburgh, C.R., Bern, C.J. & Brumm, T.J. (2008). Grain moisture and weight. In *Managing grain after harvest*, an internal textbook used in the Department of Agricultural and Biosystems Engineering, Iowa State University.

Hurburgh, C.R. & Lawrence, J.D. (2003). The need for QMS. *Resource: Engineering and Technology for a Sustainable World,* 10(9), September 2003, 29.

Hurburgh, C.R. & Hansen, R.S. (2002). Quality management systems for agriculture: Principles and case studies. Presentation given at the 2002 Integrated Crop Management Conference, Ames, IA, December, 2002.

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. *Journal of Agricultural Safety and Health*, 11(4), 395-405.

Keren, N., Mills, T.R., Freeman, S.A., & Shelley, M.C. (2009). Can level of safety climate predict level of orientation toward safety in a decision-making task? *Safety Science,* 47(10), 1312-1323.

Laux, C.M. (2007). The impacts of a formal quality management system: A case study of implementing ISO 9000 at Farmer's Cooperative Company, Iowa. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International B68/07.

Laux, C.M. & Hurburgh, C.R. (2010). Using quality management systems for food traceability. *Journal of Industrial Technology*, 26(3).

Laviana, H. (May 23, 2010). 60 killed in grain elevators in Kansas since 1980. *The Wichita Eagle*. Downloaded May 28, 2010 from http://www.kansas.com/2010/05/24/v-print/13261/60-killed-in-grain-elevators-since.html

Lehtola, C.J., Brown, C.M. & Becker, W.J. (2008). Grain handling facilities – OSHA standard 1910.272. (ABE208). Gainesville, FL: Institute of Food and Agricultural Sciences, University of Florida. Downloaded June 16, 2008 from http://edis.ifas.ufl.edu/pdffiles/OA/OA11000.pdf.

Levin, S.L. (1999). Development of an instrument to measure organizational trust. Unpublished doctoral dissertation, The George Washington University. Dissertation Abstracts International A60/02.

Liebowitz, J. (1999). Key ingredients to the success of an organization's knowledge management strategy. *Knowledge and Process Management*, 6(1), 37-40.

Luning, P.A. & Marcelis, W.J. (2007). A conceptual model of food quality management functions based on a techno-managerial approach. *Trends in Food Science and Technology*, 18, 159-166.

Mills, T.R. (2007). The effects of a safety climate on safety decision-making. Unpublished master's thesis, Iowa State University.

Miranowski, J.A., Jensen, H.H., Batres-Marquez, P., & Ishdorj, A. (2004). *Product differentiation and segregation in agricultural systems: Non-Genetically modified and specialty corn and soybean crops in Iowa.* (Paper No. 04-WP 354). Ames, IA: Center for Agricultural and Rural Development.

National Safety Council (1999). Injury facts. Itasca, IL.

Reed, C.R. (2006). *Managing stored grain to preserve quality and value.* St. Paul, Minnesota: American Association of Cereal Chemistry International.

Roberts, M. & Field, B. (2010). A disturbing trend: U.S. grain entrapments on the increase. *Resource: Engineering and Technology for a Sustainable World,* July/August 2010, 10-11.

Salazar, N. (1989). Applying the Deming philosophy to the safety system. *Professional Safety*, 34(12), 22-27.

Saraph, J.V., Benson, P.G., & Schroeder, R.G. (1989). An instrument for measuring the critical factors of quality management. *Decision Sciences*, 20(4), 810-829.

Thakur, M., Mosher, G.A., Brown, B., Bennet, G.S., Shepherd, H.E. & Hurburgh, C.R. (2009). Traceability in the bulk grain supply chain. *Resource: Engineering and Technology for a Sustainable World,* April/May 2009, 20-22.

Voigt, J. (2005). Maintaining quality and purity in commercial elevators and equipment. Proceedings of the Grain Elevator and Processing Society (GEAPS). Downloaded on February 23, 2009 from http://www.geaps.com/proceedings/2005/voigt.cfm.

Zohar, D. (2000). A group-level model of safety climate: Testing the effect of group climate on micro-accidents in manufacturing jobs. *Journal of Applied Psychology,* 85(4), 587-596.

Zohar, D. (2008). Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46(3), 376-387.

Zohar, D. & Erev, I. (2007). On the difficulty of promoting workers' safety behavior: Overcoming the underweighting of routine tasks. *International Journal of Risk Assessment and Management*, 7(2), 122-136.

Zohar, D. & Luria, G. (2005). A multilevel model of safety climate: cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4), 616-628.

CHAPTER 2. LITERATURE REVIEW

This literature review addresses five broad topics. The review is not intended to be exhaustive. Topics addressed provide the theoretical grounding for topics included in the research articles and the overall dissertation research. The topics reviewed include: (1) the definition and meaning of trust as it has been described and interpreted by researchers, (2) a review of previous findings on the impact managerial and supervisory trust has on organizational safety outcomes (3) previous research and theory on worker behavior, focusing on the central question of why workers continue to make decisions which run counter to workplace safety and quality, (4) an examination of the role trust levels play in quality and quality management in the workplace, including past research on quality management in agricultural production and processing, and (5) decision-making theory and its use in the measurement and prediction of decisions in safety and quality scenarios.

TRUST

Several factors may influence employee perceptions of safety and quality within an organization. One of these factors is believed to be trust, which has been shown to play a role in several workplace dynamics such as employee cooperation, problem solving, and high quality communication (Dirks & Ferrin, 2002; Kramer, 2006). The concept of trust has been examined from researchers in a variety of disciplines. Researchers have framed antecedents, meaning, and conditions of the deceptively complex topic of trust. Exploration in disciplines such as psychology, business, management, leadership, and safety has also made important contributions to the understanding of trust in the workplace.

Most theoretical definitions of trust acknowledge two parts: 1) a willingness to be vulnerable to another party to perform expected and desirable actions even though the party cannot be managed or scrutinized and 2) the implication that this vulnerability leads to a certain degree of risk or dependency on the other party to act in a benevolent manner (Dirks & Ferrin, 2002; Kramer, 1999; Mayer, Davis, & Schoorman, 1995; Shockley-Zalabak, Ellis, & Wingrad, 2000; Slovic, 1993; Whitener, Brodt, Korsgaard, & Werner, 1998). Both parts play an important role in defining trust. Vulnerability is central to the definition because trusting relationships must have meaningful incentives on the line, leading to the possibility of the trust being breached from the trustee's perspective (Davis, Schoorman, Mayer, & Tan,

2000). Without the uncertainty inherent to risk and vulnerability and the possibility of the second party not following through on promised actions, no trust would be necessary within relationships. The need for trust only becomes important when an uncertain situation occurs (Rousseau, Sitkin, Burt, & Cameter, 1998).

Trust has been identified as an important factor in several positive organizational outcomes, including high quality communication, performance levels, constructive citizenship behaviors, increased problem solving, and employee cooperation (Whitener et al., 1998). Employee trust levels in the management team and the supervisor may be dependent on items such as the prior beliefs of employees, organizational change, supervisory and management practices, and perception of risk (Albrecht, 2002; Cufaude, 1999; Poortinga & Pidgeon, 2004; Slovic, 1993; Zohar, 2000, 2002). However, even when considering multiple contributing factors, employee trust levels are fundamentally based on the employees' perceptions of the top management and supervisor.

Various dimensions of trust have also been explored by researchers, including trust relations between managers and workers (Albrecht, 2002; Dirks & Ferrin, 2002; Mayer & Gavin, 2005; Mayer et al., 2005; Whitener et al., 1998; Willemyns et al., 2003); the violation and repair of trust (Kim et al., 2006; Schweitzer et al., 2006; White & Eiser, 2006); trust in high-reliability organizations (Conchie & Burns, 2008; Cox et al., 2006; Flin et al., 2000; Mullen, 2004); and the relationship between conditions and constructs of trust and distrust (Conchie & Donald, 2008; Jones & George, 1998; Lewicki, McAllister, & Bies, 1998).

The meaning of trust is deceptively complex. Several constructs of trust appear in multiple definitions and use different words to describe similar concepts across several definitions. Although researchers have not come to complete agreement on the constructs which explain trust, the following five constructs are frequently used to describe its meaning.

Consistency is identified by several researchers as a condition of trust (Butler, 1991; Clark & Payne, 1997; Levin, 1999; Whitener et al., 1998). Other researchers use alternate words to describe the same action, including reliability (Mishra, 1996; Shockley-Zalabak et al., 2000), past actions (Currall & Epstein, 2003) and predictability (Gabarro, 1978). Although predictability, reliability, and past actions may play a role in a trusting relationship, significant trust must surpass these. Depending on the resulting action, predictability,

reliability and history of past actions can be a positive or negative characteristic (Mayer et al., 1995). For example, if a supervisor continually makes poor decisions, employees may be able to accurately forecast his or her decision, but still not trust him or her to make positive organizational and group level decisions.

Given this, consistency does form a basis for trust because of its emphasis on reliable behavior and its significance in leader actions (Mishra, 1996). Dependable and consistent behavior is grounded in a correspondence between the actions and the words of management and supervisory personnel across both events and experiences over a period of time (Shockley-Zalabak et al., 2000). Nearly all trust definitions include an aspect of vulnerability, but consistent behavior on the part of the management and supervisors allows employees to increase their confidence in their ability to predict behavior. Consistent behavior and congruence between words and actions helps lower the vulnerability of the employee, increasing his or her trust levels, while inconsistencies between words and actions decrease trust levels in employees (Shockley-Zalabak et al., 2000; Levin, 1999).

A second common construct of trust which has been proposed by several researchers is credibility. Many words can be used to describe credibility (integrity, honesty, moral character, fairness, etc.), but from an employee perspective, high credibility is characterized by consistency between words and deeds (Whitener et al., 1998). Although credibility is similar to consistency, the construct goes beyond the expected alignment of the administrator's actions and words. Mayer et al. (1995) suggests that a key additional point is the role of the trustor as an important component of credibility perceptions and the importance of congruence between the values of the trustor and the trustee. Without agreement on values, the actions of the trustee may be perceived as only consistent rather than credible.

Another construct of trust identified by several researchers is competence. Competence is characterized by level of knowledge and skill and how these are employed by the organizational leadership to make decisions (Clark & Payne, 1997; Mishra, 1996). Davis et al. (2000) and Shockley-Zalabak et al. (2000) expand the definition to include trust in the effectiveness of the leadership and of the organization's potential survival in the marketplace. Mayer et al. (1995) add an important condition to the construct of competence – the limited

amount of trust given to supervisors or management when they are outside of their area of expertise.

A fourth construct frequently identified when defining trust is concern or benevolence. Mayer et al. (1995) defines benevolence as the extent of concern the trustee has for the trustor. Mishra (1996) characterizes concern as the perception that one party will not take advantage of another when the other is vulnerable. Whitener et al. (1998) consolidates both definitions into three actions: 1. demonstrating thought and responsiveness to the needs and interests of employees, 2. protecting employee interests by sensitive actions, and 3. balancing personal interests against the interests of others. Shockley-Zalabak et al. (2000) and Edmondson (1996) describe concern as a culture which builds psychological safety by emphasizing their social capital. The sincerity of caring, empathy, and tolerance allows for an organization which treats mistakes as learning opportunities rather than as reason for punishment. Shockley-Zalabak et al. (2000) particularly emphasize the role of the sincerity in the above feelings for building organizational trust among employees.

The final significant construct defining the meaning of trust is perhaps the most important because without communication and openness, none of the other constructs would carry the same weight. The construct of communication and openness includes actions such as the timely sharing of accurate and relevant information, explanations of decisions under consideration or already made, and an open, non-defensive, and sincere delivery of the information to all relevant parties (Cufaude, 1999; Levin, 1999; Mishra, 1996; Shockley-Zalabak et al., 2000; Whitener et al., 1998). Mishra (1996) suggests openness plays an especially key role in trust between managers and subordinates, but also cautions that extreme openness may actually decrease trust rather than increase trust levels.

The constructs listed above do not provide the full scope of all published definitions. Universal agreement on a definition of trust is still in development, but most researchers agree on some general properties of trust. Several researchers (Currall & Epstein, 2003; Poortinga & Pidgeon, 2004; Slovic, 1993; Willemyns et al., 2003) have theorized that trust is difficult to gain, but easy to lose. The general philosophy of trust is that it is built up based on a series of positive acts over a long period of time but may vanish instantly with one

negative incident. This imbalance of emotion has been termed the asymmetry principle by Slovic (1993) and others.

The asymmetry principle is thought to have a major impact on how people perceive information. Difficulty in building trust is illustrated by what Siegrist and Cvetkovich (2001) label a "negativity bias", which helps explain why people find negative information to be more convincing than positive information. White et al. (2003) suggested that negative information is often clear and unambiguous while positive information may be fuzzy and more indirect, which can lower trust levels rather than increasing them. Kramer (1999) also found a person's position within an organization played a role in how information was received. People in lower status positions tended to be more aware of the trust dynamic between the worker and supervisor, in part because of their greater vulnerability and dependence on the decisions made by those in higher status positions (Kramer, 1999).

These theories are supported by Mayer et al. (1995), which also include the trustor's propensity to trust as a major component of their model. This propensity is thought to be determined at least in part by prior beliefs and attitudes (Poortinga & Pidgeon, 2004). Although the role of the trustee's prior beliefs and attitudes is not fully known, researchers have established that these emotions do play a part in trust perception.

TRUST IN THE WORKPLACE

In the workplace, trust has several important implications for both workers and management (Willemyns et al., 2003). Davis and Landa (1999) found that 43% of workers believe their managers cheat or lie to them, and 68% do not trust their managers, but they did not investigate how this impacted workplace safety or quality. Conchie and Donald (2008) found that trust-related properties played a substantial role in the development of a safe workplace. Other safety researchers have found that trust effects safety related outcomes both directly and indirectly (Burns, Mearns & McGeorge, 2006; Conchie & Burns, 2008; Cox et al., 2006).

In 1993, the Human Factors Working Group of the Advisory Committee on Safety in Nuclear Installations (ACSNI) highlighted the importance of communications based on reciprocal trust, shared viewpoints on the role of safety, and by high assurance in the

effectiveness of preventive measures (Cox et al., 2006). Several human-engineered facets have also been identified as having a positive impact on safety. These include: senior management commitment to safety, concern over the impact of hazards upon workers, reasonable and flexible rules and policies concerning hazards, and opportunities for continuous improvement in safety (Cox et al., 2006).

The connections between trust-related factors and organizational safety climate have not been studied extensively. Baas (2002) found correlations between both safety climate and trust measures with accident rates. Although this provides a link between organizational trust and employee behavior, the behavior metric is a lagging indicator rather than a leading indicator. Little research has explored the relationship between trust, safety climate and a leading behavioral indicator. Lagging indicators remain the norm for using organizational climate to predict safety behavior (Hudson, 2009; Johnson, 2007; Keren et al., 2009; Pousette et al., 2008; Zohar & Luria, 2005). Indeed, this remains a challenge for safety researchers – finding a leading indicator accepted by management that has a predictive relationship with employee behavior. Safety climate has the potential to serve as a leading indicator, but a lack of conclusive predictive power and acceptance from industry has limited efforts to use this metric (Keren et al., 2009). This detail has not prevented safety researchers from attempting to model safety climate against a variety of factors, including trust. The next section will discuss some of the research completed to measure the relationship between trust and safety climate.

SAFETY CLIMATE AND TRUST

Safety climate is a measurement tool used to provide organizations with a snapshot of employee perceptions on the priority of organizational safety compared to other organizational outcomes such as productivity or quality (Zohar, 2000). The important direct effect of safety climate on employee behavior has been demonstrated (Johnson, 2007; Keren et al., 2009; Neal, Griffin & Hart, 2000; Zohar, 2002), but this finding has not been universal (Cooper & Phillips, 2004; Garavan & O'Brien, 2001; Vredenburgh, 2002). Replication and validation of the effect of safety climate on employee behavior has been limited in many cases because few safety climate instruments have been used multiple times or in multiple

work environments (Seo et al., 2004). After over 30 years of research on the topic (Zohar, 1980), the 2002 study by Zohar was one of the first to confirm that worker perceptions of safety were significantly linked to accident and injury rates. This linkage has important implications for supervisory and management teams who wish to reduce safety incidents in their organizations.

Several factors affect the level and strength of safety climate. Flin et al. (2000) found five themes which commonly describe the organizational safety climate. These include: management and supervision, safety systems, risk, work pressure, and competence. Other researchers point to the importance of open communication in building safety climate (Conchie & Burns, 2008; Cox et al., 2006). Additional important components affecting safety climate include: management and supervisory practices, management values, and employee involvement (Neal et al., 2000). Although many items may affect safety climate, the links between management practices and communication and safety are grounded in the trust levels workers have in both supervisors and management and this will be the focus of this research (Conchie & Burns, 2008).

The role of the supervisor and top management on safety climate has been discussed by many researchers (Arboleda et al., 2003; Keren et al., 2009; Petersen, 2000; White & Eiser, 2006; Whitener et al., 1998; Zohar, 2000,2002; Zohar & Luria, 2005;), but few have specifically studied trust (McClain & Jarrell, 2007). Trust has been implied as a contributing factor in discussion and analysis section of previous studies (Clark, 1999; Conchie & Burns, 2008; Mullen, 2004; Seo et al., 2004) but little research has measured the strength of the relationship at multiple levels (Zohar & Luria, 2005).

Furthermore, few studies have tested the impact of trust on safety climate, yet low trust levels have been linked to many negative safety and organizational outcomes. Several factors may contribute to these outcomes. First, a lack of trust in administrators may divert the employees' attention from their assigned tasks (Mayer & Gavin, 2005). Moreover, employees' who are concerned or worried about the behavior of their boss may not be focusing on improving their own work or concentrating on their personal safety. Additional outcomes of low trust work environments may include increased attempts to break

management rules or setting inappropriate goals contradicting to the organizational objectives (Davis et al., 2000). Although Davis et al., (2000) did not test safety specifically, setting inappropriate safety goals or attempting to "get away" with not following safety rules could prove extremely dangerous and possibly deadly.

Zohar and Luria (2005) present a multilevel model of safety climate based on a theoretical framework outlined by Zohar (2000, 2003). The model attributes some variation in safety climate to the dynamics of the work group. This model assumes that employees are continually presented with a large number of inconsistent and conflicting demands from both management (termed organizational climate) and supervisors (work group climate). A second assumption is that although the management may create and develop policies and regulations, the daily implementation of the resulting actions and tasks are left to the supervisor. Supervisors are often left to interpret management mandates with a great deal of flexibility, resulting in variation between supervisory groups. Based on these assumptions, the implications from Zohar and Luria's (2005) work are clear – when employees and supervisors are faced with competing demands, they will choose the behavior that is perceived to be the higher priority. If the priority behavior is safety, the choice will be safe behaviors. If the productivity has the higher priority, tasks will be completed with speed in mind rather than safety.

In addition to the multiple attempts to define the constructs of safety climate, an additional challenge for safety researchers has been validating a relationship between safety climate and safety behaviors. Zohar (2000) and Zohar and Luria (2005) have set the stage for work in this area as well. Additionally, Johnson (2007) was able to confirm the predictive validity of Zohar and Luria's (2005) safety climate survey. Using the Zohar and Luria Organizational-Level and Group-Level Safety Climate instruments, Johnson (2007) corroborated a link between safety climate and injury rates with safe behaviors as a mediating effect. The same safety climate instrument (Zohar & Luria, 2005) also directly predicted safe behavior and injury severity (as measured by lost work days) (Johnson, 2007).

The level of safety climate describes the employee perception of the weight of safety issues in work performance and the strength of the safety climate measures the level of

agreement concerning the safety climate level (Zohar, 1980). Although the two measurements may be positively related, this is not always the case. Of the two measurement indicators, Zohar and Luria (2005) determined the level of safety climate has a more significant effect on organizational safety than does safety climate strength.

Implications from research on safety climate and safe behaviors suggest managers and supervisors should focus on developing a proactive environment which promotes safe behaviors rather than a punishing environment which reacts to injuries and incidents (Johnson, 2007; Zohar, 2000; Zohar & Luria, 2005). This finding was echoed by Vredenburgh (2002). Her study of management practices identified two major predictors of employee injury rates in a hospital environment. These included: hiring individuals based on a good safety record and proactively addressing near-miss incidents and correcting the underlying cause before a recordable incident occurs. The study concluded that although safety training should be used, it is not adequate when used alone. Vredenburgh (2002) also suggested that hospitals who proactively protect their employees' safety may gain a financial benefit resulting from reduced lost "down" time and worker compensation expenditures.

Although Vredenburgh (2002) found safety training to be less effective when used without corresponding safety messages, other researchers have found safety training to be important predictors of safety climate (Mullen, 2004; Neal et al., 2000; Wu et al., 2007). Wu et al. (2007) concluded that additional safety training would lessen employee risk exposures and improve employee safety behavior, resulting in fewer incidents. This study also suggested safety training would improve the employees' emergency responses to safety incidents. In an agriculture setting, Murphy (2003) notes that although educational approaches have been used in the past, long term effectiveness and behavior change as a result of the educational intervention is questionable. Given this, he does not advise the abandonment of educational approaches.

Neal et al. (2000) found organizational climate was a significant influence on safety climate and safety climate was linked to self-reported safety compliance. Although mediating effects of safety climate links safety performance to organizational climate, no direct relationship was found between organizational climate and safety performance. When

considering the results of this study, it is important to remember that organizational climate encompasses a broad range of workplace perceptions and safety is only one of many evaluations made. However, the influence of organizational climate has been found to influence several organizational outcomes (Neal et al., 2000) and a key component of organizational climate is employee perception of organizational leadership (James & McIntyre, 1996).

Management and supervisor safety attitudes have been shown to effect safety climate, but the magnitude of this effect has differed (Clark, 1999; Cooper & Phillips, 2004; Flin et al., 2000; Seo et al., 2004). Cooper and Phillips (2004) characterize the relationship as complex, with changes in perceptions not always resulting in safety performance and vice versa. They cite the use of self-reported safety performance outcomes as a key limitation in measuring the relationship between safety climate and safety performance. Flin et al. (2000) suggest safety climate components and themes vary greatly according to differences in industry, company, and work practices.

Clark (1999) found organizational perceptions of workers, supervisors, and managers to be positive, but noted a lack of understanding and incorrect perceptions among groups. Negative or incorrect perceptions may incorrectly influence group beliefs. Because perceptions are not necessarily based on fact, but rather the employees' interpretation of facts, correct information about group safety perceptions is important for managers to remember when making judgments about workers in different hierarchy levels (Clark & Payne, 1997). In addition, prior beliefs, employee attitudes, and individual differences have also been shown to affect perceptions (Henning et al., 2009; Poortinga & Pidgeon, 2004) and these differences must be considered when communicating with employees.

Furthermore, Das et al. (2008) note that safety climate has a significant perceptual component. This means employees may recognize and construe information or episodes quite differently and the management and supervisors may have little control over these perceptions. Keren et al. (2009) reiterate this, stating that employees do not respond directly to workplace incidents, but perceive and interpret events which occur in their work environment before taking action.

Because perceptions are not necessarily based on fact, but rather the employees' interpretation of facts, correct information about group safety perceptions is important information for managers and supervisors (Clark & Payne, 1997). Prior beliefs, employee attitudes, and individual differences have also been shown to affect employee perceptions (Henning et al., 2009; Poortinga & Pidgeon, 2004). Even after over 30 years of research attempting to predict workers' safety behavior, researchers still have no conclusive model to predict accidents before they occur. They are limited to analyzing the accident after the fact, which is subject to a great deal of bias.

Although post-accident analysis provides valuable information, understanding factors which predict or characterize unsafe employee behaviors before they occur would be an even better tool for managers and supervisors. Although no past model has been able to explain or predict safe behaviors before they happen, this has not kept researchers from attempting to understand why workers behave in an unsafe way. The next section summarizes research in this area.

WORKER SAFETY BEHAVIOR

Two main angles of research on the safety behavior of workers will be overviewed in this review. First, one set of researchers have attempted to explain the ways employees violate safety rules and the factors which may contribute to unsafe behavior. A second group tries to predict employee behavior by identifying factors and creating predictive models. Neither provides a complete answer, but they do help to partially explain why workers routinely violate the long-held assumption of self-preservation in the workplace.

Hofmann et al. (1995) and Simard and Marchand (1995) report that safety behavior is related to organizational and group level influences. Hofmann et al. (1995) point to two broad factors: a lack of respect for technology driving workplace safety and employee attitudes. Concerning the lack of respect for technologies, the phrase "familiarity breeds contempt" seems the best descriptor. This thought is forwarded by Zohar and Erev (2007), who also site a flawed weighting of hazards by the employee and the delayed and uncertain occurrence of negative outcomes resulting from not following safety procedures as major contributors towards irresponsible behavior. Worker attitudes are generally defined as a

failure to wear protective gear, failure to follow procedures, and insufficient training (Hofmann et al., 1995; Kouabenan, 2009; Reason et al., 1998)

Simard and Marchand (1995) point to factors at several levels, including micro and macro organizational levels. They report that micro level factors such as work processes, hazards, and work group cohesiveness contribute to workers' willingness to take safety initiatives. In their work, they found that many micro level factors are influenced by macro-level factors such as managerial support and commitment. Numerous researchers have found supervisory and management commitment to be an important part of organizational and group safety outcomes (Clarke & Ward, 2006; Thompson et al., 1998; Zohar, 2000). However, after an accident, several researchers have noted the difference in perceptions between managers and first-line supervisors and coworkers of the victim. While the former generally attribute accidents to attitudes, knowledge, and behaviors of workers, the later blame the work environment, systemic weaknesses in safety or simple bad luck (Kouabenan, 2009; Prussia et al., 2003; Walker, 2010). Conflicts between these two groups can negatively impact intervention programs aimed at improving workplace safety outcomes so resolving differences in perceptions between the groups should be a priority for managers and supervisors who are serious about improving safety. Prussia et al. (2003) suggest the way to do this is the improvement of organizational safety climate. Zohar (2000) adds that the improvement of group safety climate also promotes safer behavior by employees.

According to the Occupational Safety and Health Administration, 85% of workplace accidents result from unsafe behaviors (Anonymous, 2010), so understanding factors which predict workplace accidents is a high priority for researchers. Mullen's (2004) qualitative work identified several individual factors which helped explain unsafe behaviors. Some of these include: role overload, performance versus safety, peer pressure, and avoidance of negative consequences. The first two factors address a common theme in the safety literature – the continual conflict between safety and productivity (Kouabenan, 2009; McClain & Jarrell, 2007). Additionally, although peer pressure can be position or negative, it is the negative pressure from peers that is typically highlighted in the literature (Keren et al., 2009; Mullen, 2004). Avoidance of negative consequences can be traced back to the commitment and support management and supervisors give to safety (Brown et al., 2000; Choudhry &

Fang, 2008; Seo, 2005; Zohar & Luria, 2005). Mullen (2004) uses the loss of a good job as an example of a potential negative consequence. From an employee perspective, all of the above factors would negatively impact their commitment to safety.

Mullen also mentions a factor that is especially prevalent in high reliability industries – defined as industries where safety is of utmost importance - and this is the worker's "image". Several interviewees reported taking unsafe risks to impress either supervisors or co-workers for the purpose of securing a job promotion or gain status within the organization or work group (Choudhry & Fang, 2008; Mullen, 2004). Zohar and Erev (2007) suggest that these types of behaviors can be either encouraged or discouraged by supervisors and management but that they must actively provide feedback and observation. Rewarding good behavior on a consistent basis is also suggested to alleviate risk-taking behaviors among employees.

Dekker (2002) takes a different approach, focusing on behavior after the accident occurs. Because many accidents are the result of human error, it is important to understand why people acted the way they did rather than attempting to judge them with the luxury of hindsight. Dekker (2002) points out that hindsight adds bias and, along with the pressure to find a "fall guy" after a fatal accident or serious injury, works against the process of learning the mindset of the victim during his or her ordeal. Rather, he suggests that investigators focus less on the mistake and more on learning from the mistake. Instead of asking why the employee made the fatal error, he advises investigators to understand why the employee felt his or her actions were positive in that context.

Edmondson (1996) also focuses on accident analysis but in situations which are typically not fatal to employees. She terms the ability to openly discuss mistakes and errors without retribution from supervisors or management as "psychological safety". Her work within the hospital environment made the surprising discovery that the most functional work teams were those with the highest reports of medical errors rather than those groups with low error rates. What she found was that reporting of errors was linked to the perceived openness and acceptance of group leaders to errors committed by the team. Ironically, she concluded that work teams with the greatest need for improvement are the most unlikely to report errors which could improve their performance.

Edmondson (1996) suggested that these findings also had implications for the management of quality performance and improvements. The importance of work teams and their ability to find and correct errors may be disabled by group tensions or ineffective communications. These connections and other quality management research within the agricultural production and handling industry will be discussed in the next section.

QUALITY MANAGEMENT IN AGRICULTURE

Process controls and verification of standards inherent to quality management systems are not new to many industries, but these ideas are very new to bulk commodity handling and processing firms (Hurburgh & Lawrence, 2003). Preliminary research on the use of quality management systems within a bulk commodity handling and processing facility demonstrated several benefits including increased operating efficiency, a better ability to meet customer specifications, and tighter food security controls (Laux, 2007; Laux & Hurburgh, 2010).

The global framework for quality management is the ISO 22000 and 9001 series of standards. The adoption of ISO quality standards forces a greater control of processes, an increased discipline and reproducibility, and continuous improvement within an organization. Quality is an important operational goal for many firms. As quality processes improve, benefits such as reduced waste, lower costs, and increased firm performance are often noted (Sroufe & Curkovic, 2008).

Although some companies pursue quality management systems at the request of their customers (Davis, 2004; Willem, 2004), a lack of internal motivation could limit the realization of organizational benefits. For this reason, an internal champion is an important part of the success of quality management programs (Chrusciel, 2004). Programs pushed from the top down are especially vulnerable to failure (Sroufe & Curkovic, 2008). Even when a quality management system creates operating efficiencies and increases profits – giving clear benefits to the firm- implementation of such a system in bulk commodity handling presents several challenges.

Among the most significant challenges is the business environment (Hurburgh & Hansen, 2002; Voigt, 2005). A commodity-based business focuses on large volumes, with

low profit margins, for the lowest cost. Although adoption of quality management has the potential to create opportunities for increased efficiency and profits (Laux, 2007), recognition of these advantages remains a major priority for employee training and education.

A second obstacle for the commercial grain handling industry is that the management of quality in agricultural commodities is changing (Hurburgh & Lawrence, 2003). Production agriculture is becoming more focused on product isolation, source verification, traceability and other differentiation processes that add value to bulk commodity crops and respond to consumer, regulatory, and industry needs (Miranowski et al., 2004). Even outside specialty markets, the quality of grain is a key consideration in its storability, marketability, and end uses (Reed, 2006). In both existing and emerging agricultural markets, efficiencies in bulk grain handling can be facilitated through a quality management system (Laux, 2007; Thakur et al., 2009).

These systems have been used in manufacturing to improve efficiency and maintain high levels of quality (Bowersox, Closs, & Cooper, 2007; Das et al., 2008; Deming, 2000), but have had limited use in bulk commodity agricultural handling (Hurburgh & Lawrence, 2003). However, the need and receptivity in bulk commodity handling is shown by the growth in quality management system certification in this sector (ISO, 2005).

Historically, the United States competed strongly with other grain-producing nations, but as other nations improve processes, increase production capability, and escalate their use of technology, commodity crops grown in the United States have lost much of the competitiveness they once had in terms of both price and quality (Laux, 2007). The commodity-based system that has been in use for nearly 100 years has several inadequacies that are not managed well by the current system of grain handling and management. These include (Adam & Hong, 2001):

- Because the system has a limited ability to separate high grade grain from low grade grain, all grain is assumed to meet only the minimum standard grade;
- No way exists to quickly differentiate high value traits at the grain elevator, so producers have no motivation to produce high value traits;
- Grain elevators have little incentive to encourage high quality grain because they profit from discounts charged to the producer;

- Blending low quality grain with higher quality grain to form a consistent level of grain quality is another form of profit for grain elevators;

- Elevators are hesitant to pay quality-adjusted prices because they risk losing a customer if they do not offer a competitive commodity-based price; and

- Producers tend to be fairly risk adverse – they prefer a known market (certain price with well-defined discount rates) rather than a more speculative market price (Adam & Hong, 2001)

Quality management systems by way of ISO certification are offered by Caswell et al., (1998) as one option to increase agricultural competitiveness and efficiency in the global marketplace. Capmany et al. (2000) note that commodity agricultural products could realize more benefits of quality management systems, particularly in the areas of firm image, waste reduction, and costs of inventory management, but acknowledge the uncertainty regarding the costs and benefits of such systems. Initial studies on quality management systems within the agricultural handling industry have shown both benefits (Holleran et al., 1999; Laux, 2007; Laux & Hurburgh, 2010; Mumma et al., 2002) and additional costs (Capmany et al., 2000; Holleran et al., 1999).

Most studies of ISO 9001 and ISO 22000 use in agriculture have aligned with general research on the subject in that the firms who embrace the change in management practices and use the certification process to improve quality processes benefit the most of the use of quality management systems (Sroufe & Curkovic, 2008). Laux (2007) identified several of the core processes needed for the development of a quality management system in a grain handling environment. These include: receipt of the product, storage of product, and shipping the product to the next user. The limited storage life of grain products is a significant consideration in managing the quality of such products (Fleurat-Lessard, 2002; Reed, 2006). Therefore, a key component of such a system is the appropriate handling and storage of incoming raw materials (Luning & Marcelis, 2007). These duties fall to employees and their decisions on how to handle and store grain products can have a large impact on the success of such systems. Luning and Marcelis (2007) acknowledge that although technical actions typically dominate quality management models, considering only the technical actions is an overly simplistic approach. They list 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.

The gap between the technical conditions and human dynamics can be partially addressed by quality decision-making research. The decisions made by employees have a clear role in any given quality management system. Understanding this role has the potential to improve the quality system processes, which in turn may improve quality performance at both the organizational and group level.

DECISION-MAKING THEORY

To address the gap between the perceptions of employees and the safety-related behavior of employees, Keren et al. (2009) established a framework for an examination of the relationship between safety climate and safety decision-making, where the decision making process reflects proximate behavior. The concept is defined by processes which are thought to play a role in the safety-related decisions employees make on the job. This work also introduces the concept of quality decision-making and the processes which are hypothesized to play a role in decisions concerning workplace quality systems. The next section of the literature review will provide an overview of the topic of decision making as it relates to occupational safety and management of quality.

The safety decision scenario in this work explores personal risk while the quality decision scenario involves business risk. Amendola (2001) summarizes decision making under risk as a three step process: establish probability and degree of the hazard, assess the benefits and costs, and establish priorities so that the greatest benefits can be realized at the lowest cost. Although Amendola's decision making paradigm does not specifically address safety, many of its features are applicable in a safety environment. When making risky decisions (often the case with safety-related decisions and in some quality decisions), Slovic (1993) asserts that the decision making process may not follow a rational pattern, and therefore, may not conform to any standard decision making theories.

Several other psychological theories on decision-making help explain a worker's decision-making process under risky conditions. Traditionally, a fundamental basis for risky decision-making has been the Expected Utility Theory (EUT) which posits that when people

make risky decisions, they weigh several options and the likelihood of each occurring (Newell, Lagnado & Shanks, 2007; Zohar & Erev, 2007). The option with the highest "utility" to the decision-maker is the final decision choice. However, the process is not always so straightforward. When comparing benefits between safe behaviors and unsafe behaviors under the framework of the EUT, unsafe behaviors are clearly favorable to the employee in terms of effort and time expended (Zohar & Erev, 2007), even though the decision choices are obviously unsafe and therefore, have a lower utility to the decision-maker. The choice of an unsafe option also refutes the long held assumption that self-preservation outweighs other employee motivations (Maslow, 1970).

Several violations to the EUT have been noted by researchers over the years, with three noted by Newell et al. (2007). Researchers have doubted the ability of humans to act rationally when making decisions, due in part to limitations in cognitive processing and availability of information. Notably, Herbert Simon (1955, 1956) redefined the human decision-making process as one which took advantage of the restricted information and cognitive resources to make a decision that were "good enough" rather than ideal in terms of utility.

A second criticism of EUT in decision-making was offered by Edwards (1968) and Tversky and Kahneman (1974). They proposed that decision-making behavior used mathematical principles such as probability and probabilistic judgment, expanding the possibilities of information acquired and how it was used before a decision was made (Newell et al., 2007). The research served as a basis for the use of Bayes' theorem and the bias and heuristic approach in decision-making research.

The final violation noted by Newell et al (2007) concerning the EUT refines the role of choice. Best represented by the Prospect Theory (Kahneman & Tversky, 1979), the theory posits that although humans attempt to make decisions maximizing their utility, both decision utility and probability are subject to cognitive distortions in the decision-making process. Although researchers have discovered many violations and weaknesses to the EUT, it still plays a large role in theoretically describing the decision-making process under risky conditions.

A second theory which explains risky decision-making is the Prospect Theory (Kahneman & Tversky, 1979). The Prospect Theory (PT) challenges the fundamental postulation of the EUT by suggesting that people are more apt to give more attention to low-probability situations than to higher-probability occurrences – an example of the "distortions" introduced under the framework of the EUT (Tversky & Wakker, 1995). This theory also states that when a person stands to gain, risk adverse behavior is more common while those who perceive that they have nothing to lose exhibit more risk-seeking behavior. Newell et al. (2007) state that actual probabilities are often ignored by decision makers who underestimate common outcomes and overestimate rare outcomes. Additionally, Kahneman and Tversky (1979) demonstrated that decision-makers are more affected by decision outcomes that have a high probability of actually occurring rather than those that have a lower chance of happening. Both theories imply that people are more sensitive to risk than uncertainty.

Another factor which affects the utility of a decision and adds distortion to the decision process is the presence of or lack of pertinent information. Sharps and Martin (2002) propose that information retrieved to support positive decisions must be immediately accessible for it to be used. Even if applicable information is available in long term memory, books, manuals, or hard drives, information that is not seen at the time of the decision may have very little effect on the decision choice. In a safety environment, the practicality and possibility of having immediately accessible information for all potential unsafe actions is questionable if not impossible. Sharps and Martin's (2002) calls into question the fundamental assumption of educational intervention and training.

Murphy (2003) applies a model similar to Amendola's in an agricultural safety setting. The model involves four steps: assessing the problem, identification of risks (hazards), evaluating what works in addressing the problem, and a final implementation step. He links the approach to traditional models developed in the public health sector, where the overriding goal is behavior change. This approach goes beyond a one-time decision, and this is true for lasting occupational safety and quality as well. Murphy (2003) notes two behavioral models which could be applied in both a safety and quality scenario. These models are the Theory of Reasoned Action and the Theory of Planned Behavior. Both posit

that behavioral intentions immediately precede behavior. In both theories, the person will follow their intended action if the said behavior will lead to a desirable outcome, if others value the behavior, and if necessary resources and opportunities are available to support the behavior (Murphy, 2003).

However, Murphy (2003) also notes that although behavioral theories have wide acceptance, limitations of the theories do exist. Two are especially relevant to the safety and quality decision-making process. The first limitation is the issue of variance explained. Most models and theories of human behavior explain only a small amount of variance, meaning that human behavior can never be fully explained by these theories. Second, many intended behaviors are never actually carried out. This is the case, not only in cases of public health and safety, but also in workplace safety and quality intentions. Most models do not account for those who fail to convert intentions into actions (Murphy, 2003).

Another position on the Theory of Planned Behavior is offered by Fogarty and Shaw (2010) and this examines human error. Psychologists differentiate simple errors (defined as unintentional) from violations, in which employees willfully disregard safety procedures. Fogarty and Shaw (2010) argue that safety violations are explained by the psychological Theory of Planned Behavior. In a safety context, the Theory of Planned Behavior is based on the idea that a person's behavior is a direct result of both their intentions and their perceived behavioral control. In turn, intentions are shaped by attitudes, subjective norms, and perceived behavioral control. In a work environment, subjective norms are perceived by employees based on behaviors and expectations of managers, supervisors, and co-workers while a person's prominent beliefs form the basis for many of their attitudes. Perceived behavioral control is rooted in behavior intentions, based on the individual's perception of the ease or difficulty of performing a specific behavior. The model constructed by Fogarty and Shaw (2010) included variables of management attitude, self-attitude, group norms, workplace pressures, the intention of the employee to violate the safety procedure, and the actual violations and all variables were found to be significant, accounting for a large proportion of variance in both intent to violate and violations.

Although little empirical evidence exists to link trust with quality climate and employee decision-making, the relationship can be explained theoretically by using the

theory of cognitive dissonance (Das et al., 2008). The theory was developed by Festinger (1957) and aims to explain the relationship among contradicting cognitions or "pieces of knowledge". Operationally, the theory posits that when people are confronted with conflicting cognitions (i.e., quality or speed), they will attempt to resolve these conflicts to reduce the uncomfortable state of the mind. According to Das et al. (2008), employees will address the conflicts in one of three ways: first, ignore their own judgment and follow advice of the supervisor or manager; second, ignore the opinion of management and the supervisor and follow their own judgment; and third, delay action and do nothing until they are forced to make a decision. Of course, the third option does not solve the problem; rather, it just postpones the inevitable decision path until a later time. An assumption not acknowledged by the theory relates to another decision choice – that where the employee sees no contradiction with his or her "pieces of knowledge". The model assumes that the decision in question presents a conflict of cognitions.

The trust literature provides another theoretical possibility. Davis et al. (2000) suggest that trusting relationships reduces the need for formal contracts, lessens devious behaviors, and lowers the need for hierarchical controls. Additionally, trust between two individuals is a relationship that cannot be recreated, which classifies it as a competitive advantage in terms of firm performance (Barney, 1986). Alternatively, in low trust environments, employees may have limited power to protest their frustrations so they resort to other mechanisms to fight back. These include: attempts to break management rules, setting inappropriate goals, and in a worst case scenario, sabotage (Davis et al., 2000). This differs from employee performance related behaviors in high trust environments, including empowerment of leaders, positive citizenship behaviors, and enhanced individual performance.

In this project, decision scenarios were presented to participants using Decision Mind™, a software platform using the decision process tracing method. Decision process tracing is an approach used to capture direct cognitive processes by directly evaluating the information an individual uses to form a judgment and the sequence with which the information was examined (Ford et al., 1989). Other key processes recorded include: the number of alternatives viewed, the time needed to make a choice, and the final decision. A

key advantage of process tracing is that it addresses the intervening steps between information acquisition and decision choice.

To gather this information, two methods are used: the decision board or the verbal protocol. Decision boards display possible alternatives for the decision maker to view privately while verbal protocols require the decision maker to describe to researchers what they are thinking or doing as they move through the decision process (Ford et al., 1989). Electronic decision boards provide a way to measure the decision process of an employee rather than just measuring the final decision choice.

Decision process tracing has several key advantages over self-reported questionnaires, which depend on recall ability and researcher observation of work behavior, which is cross-sectional at best and may have serious bias related to the Hawthorne and other effects. Decision process tracing also has benefits not realized with structural modeling. The former focuses on the processes humans use to analyze and gather information in preparation to make a decision choice while the later emphasizes the outcome of the decision choice (Ford et al., 1989). Mintz (2004) adds another strength of the process tracing methodology – the ability to isolate decision rules and models used in the decision-making process as well as test the association of situational and personal factors with the decision process and the final decision choice. The latter is the use of the methodology in this study.

The objectives and aims of this research were framed and grounded by the research reviewed here. The knowledge from the research reviewed in Chapter 2 was important in the experimental design, analysis of the data, and interpretation of the results.

REFERENCES

Adam, B.D. &Hong, S.J. (2001). Why don't country elevators pay less for low quality wheat? Information, producer preferences, and prospect theory. Paper presented at NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, April 23-24, 2001. St Louis, MO.

Albrecht, S.L. (2002). Perceptions of integrity, competence, and trust in senior management as determinants of cynicism toward change. *Public Administration and Management: An Interactive Journal*, 7(4), 320-343.

Amendola, A. (2001). Recent paradigms for risk informed decision making. *Safety Science*, 40(1-4), 17-30.

Anonymous. (2010). Engaged employees: Key elements of an effective safety rewards program. *Facility Safety Management*, January 2010. Downloaded January 18, 2010 from: http://ww.fsmmag.com/Articles/2010/01/Engaged%20Employees.htm.

Arboleda, A., Morrow, P., Crum, M.R., &Shelley, M.C. (2003). Management practices as antecedents of safety culture within the trucking industry: Similarities and differences by hierarchical level. *Journal of Safety Research*, 34(2), 189-197.

Baas, J.R. (2002). An exploratory study of the role of trust in safety climates and overall safety. Unpublished doctoral dissertation. Alliant International University, Los Angeles, CA. AAT 3043459

Barney, J.B. (1986). Organizational culture: Can it be a source of sustained competitive advantage? *Academy of Management Review*, 11(3), 656-665.

Bowersox, D., Closs, D., &Cooper, M.B. (2007). *Supply chain logistics management*. New York, NY: McGraw Hill.

Brown, K.A., Willis, P.G., &Prussia, G.E. (2000). Predicting safe employee behavior in the steel industry: Development and test of a sociotechnical model. *Journal of Operations Management,* 18(4),445-465.

Burns, C., Mearns, K. &McGeorge, P. (2006). Explicit and implicit trust within safety culture. *Risk Analysis*, 26(5), 1139-1150.

Butler, J.K. (1991). Toward understanding and measuring conditions of trust: Evolution of a condition of trust inventory. *Journal of Management*, 17(3), 643-663.

Capmany, C., Hooker, N.H., Teofilo, O., & Tilburg, A. (2000). ISO 9000 – A marketing tool for U.S. agribusiness. *International Food and Agribusiness Management Review*, 3(1), 41-53.

Caswell, J. Bredahl, M.E., & Hooker, N.H. (1998). How quality management meta-systems are affecting the food industry. *Review of Agricultural Economics*, 20(2), 547-557.

Choudhry, R.M. & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science*, 46(4), 566-584.

Chrusciel, D. (2004). Considerations for dealing with significant organizational change. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International A65/08.

Clark, M.C. & Payne, R.L. (1997). The nature and structure of workers' trust in management. *Journal of Organizational Behavior*, 18(3), 205-224.

Clarke, S. (1999). Perceptions of organizational safety: Implications for the development of safety culture. *Journal of Organizational Behavior*, 20(2), 185-198.

Clarke, S. & Ward, K. (2006). The role of leader influence tactics and safety climate in engaging employees' safety participation. *Risk Analysis*, 26(5), 1175-1185.

Conchie, S.M. & Burns, C. (2008). Trust and risk communication in high-risk organizations: A test of principles from social risk research. *Risk Analysis*, 28(1), 141-149.

Conchie, S.M. & Donald, I.J. (2008). The functions and development of safety-specific trust and distrust. *Safety Science*, 46(1), 92-103.

Cooper, M.D. & Phillips, R.A. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, 35(5), 497-512.

Cox, S. Jones, B. & Collinson, D. (2006). Trust relations in high-reliability organizations. *Risk Analysis*, 26(5), 1123-1138.

Cufaude, J. (1999). Creating organizational trust. *Association Management*, 51(7), 26-34.

Currall, S.C. & Epstein, M.J. (2003). The fragility of organizational trust: Lesson from the rise and fall of Enron. *Organizational Dynamics*, 32(2), 193-206.

Das, A., Pagell, M., Behm, M, & Veltri, A. (2008). Toward a theory of the linkages between safety and quality. *Journal of Operations Management*, 26(4), 521-535.

Davis, B. (2004). One standard fits all. *Professional Engineering*, 17(9), 43-45.

Davis, J.H., Schoorman, F.D., Mayer, R.C., & Tan, H.H. (2000). The trusted general manager and business unit performance: Empirical evidence of a competitive advantage. *Strategic Management Journal*, 21(5), 563-576.

Davis, T. & Landa, M. (1999). The trust deficit. *Management Accounting*, 71(10), 12-16.

Dekker, S.W.A. (2002). Reconstructing human contributions to accidents: The new view on error and performance. *Journal of Safety Research*, 33(3), 371-385.

Deming, W.E. (2000). *Out of the crisis*. Cambridge, MA: The MIT Press.

Dirks, K.T. & Ferrin, D.L. *(*2002*).* Trust in leadership: Meta-analytic findings and implications for research and practice. *Journal of Applied Psychology*, 87(4), 611-628.

Edmondson, A.C. (1996). Learning from mistakes is easier said than done: Group and organizational influences on the detection and correction of human error. *Journal of Applied Behavioral Science*, 32(1), 5-28.

Festinger, L. (1957). *A theory of cognitive dissonance.* Stanford, CA: Stanford University Press.

Fleurat-Lessard, F. (2002). Qualitative reasoning and integrated management of the quality of stored grain: A promising new approach. *Journal of Stored Products Research*, 38(3), 191-218.

Flin, R., Mearns, P., O'Connor, P. & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, 34(1-3), 177-192.

Fogarty, G.J. & Shawn, A. (2010). Safety climate and the Theory of Planned Behavior: Towards the prediction of unsafe behavior. *Accident Analysis and Prevention*, 42(5), 1455-1459.

Ford, J.K., Schmitt, N., Schechtman, S.L., Hults, B.M, & Doherty, M.L. (1989). Process tracing methods: contributions, problems, and neglected research questions. *Organizational Behavior and Human Decision Processes*, 43, 75-117.

Gabarro, J.J. (1978). The development of trust influence and expectations. In A.G. Athos & J.J. Gabarro (Eds.), *Interpersonal behavior: Communication and understanding in relationships*, (290-303). Englewood Cliffs, NJ: Prentice-Hall.

Garavan, T.N. & O'Brien, F. (2001). An investigation into the relationship between safety climate and safety behaviors in Irish organizations. *Irish Journal of Management*, 22(1), 141-170.

Henning, J.B., Stufft, C.J., Payne, S.C., Bergman, M.E., Mannan, M.S. & Keren, N. (2009). The influence of individual differences on organizational safety attitudes. *Safety Science*, 47(1), 337-345.

Hofmann, D.A., Jacobs, R. & Landy, F. (1995). High reliability process industries: Individual, micro, and macro organizational influences on safety performance. *Journal of Safety Research,* 26(3),131-149.

Holleran, E., Bredahl, M.E. and Zaibet, L. (1999). Private incentives for adopting food safety and quality assurance. *Food Policy*, 24(6), 669-683.

Hudson, P.T.W. (2009). Process indicators: Managing safety by the numbers. *Safety Science*, 47(4), 483-485.

Hurburgh, C.R. & Hansen, R.S. (2002). Quality management systems for agriculture: Principles and case studies. Presentation given at the 2002 Integrated Crop Management Conference, Ames, IA, December, 2002.

Hurburgh, C.R. & Lawrence, J.D. (2003). The need for QMS. *Resource: Engineering and Technology for a Sustainable World,* 10(9), September 2003, 29.

International Organization of Standards (ISO). (2005). The ISO survey of certificates 2005. Geneva: Switzerland.

James, L.R. & McIntyre, M.D. (1996). Perceptions of organizational climate. In: Murphy, K. (Ed.), *Individual differences and behavior in organizations*, (pp.40-84). Josey-Bass: San Francisco, CA.

Johnson, S.E. (2007). The predictive validity of safety climate. *Journal of Safety Research*, 38(5), 511-521.

Jones, G.R. & George, J.M. (1998). The experience and evolution of trust: Implications for cooperation and teamwork. *Academy of Management Review*, 23(3), 531-546.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decisions under risk. *Econometrica*, 47, 263-291

Kramer, R.M. (1999). Trust and distrust in organizations: Emerging perspectives, enduring questions. *Annual Review Psychology* 50, 569-598.

Kramer, R.M. (Ed.) (2006). *Organizational trust: A reader.* Oxford University Press: New York.

Keren, N., Mills, T.R., Freeman, S.A., & Shelley, M.C. (2009). Can level of safety climate predict level of orientation toward safety in a decision making task? *Safety Science*, 47(10), 1312-1323.

Kim, P.H., Dirks, K.T., Cooper, C.D., & Ferrin, D.L. (2006). When more blame is better than less: The implications of internal vs. external attributions for the repair of trust after a competence vs. integrity-based trust violation. *Organizational Behavior and Human Decision Processes*, 99(1), 49-65.

Kouabenan, D. R. (2009). Role of beliefs in accident and risk analysis and prevention. *Safety Science,* 47(6), 767-776.

Laux, C.M. (2007). The impacts of a formal quality management system: A case study of implementing ISO 9000 at Farmer's Cooperative Company, Iowa. Unpublished doctoral dissertation, Iowa State University, Ames, IA. Dissertation Abstracts International B68/07.

Laux, C.M. & Hurburgh, C.R. (2010). Using quality management systems for food traceability. *Journal of Industrial Technology*, 26(3).

Levin, S.L. (1999). Development of an instrument to measure organizational trust. Unpublished doctoral dissertation, The George Washington University. Dissertation Abstracts International A60/02.

Lewicki, R.J. McAllister, D.J. & Bies, R.J. (1998). Trust and distrust: New relationships and realities. *Academy of Management Review*, 23(3), 438-458.

Luning, P.A. & Marcelis, W.J. (2007). A conceptual model of food quality management functions based on a techno-managerial approach. *Trends in Food Science and Technology*, 18(3), 159-166.

Maslow, A. (1970). *Motivation and Personality* (2nd ed.). New York: Harper and Row.

Mayer, R.C., Davis, J.H. & Schoorman, F.D. (1995). An integrative model of organizational trust. *Academy of Management Review*, 20(3), 709-734.

Mayer, R.C. & Gavin, M.B. (2005). Trust in management and performance: Who minds the shop while the employees watch the boss? *Academy of Management Journal*, 48(5), 874-888.

McLain, D.L. & Jarrell, K.A. (2007). The perceived compatibility of safety and production expectations in hazardous occupations. *Journal of Safety Research*, 38(3), 299-309.

Mills, T.R. (2007). The effects of a safety climate on safety decision-making. Unpublished master's thesis. Iowa State University: Ames, IA.

Miranowski, J.A., Jensen, H.H., Batres-Marquez, P., & Ishdorj, A. (2004). *Product differentiation and segregation in agricultural systems: Non-genetically modified and specialty corn and soybean crops in Iowa.* (Paper No. 04-WP 354). Ames, IA: Center for Agricultural and Rural Development.

Mishra, A.K. (1996). Organizational response to crisis: The centrality of trust. In R.M Kramer and T.R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research*. Sage Publications: Thousand Oaks, CA.

Mullen, J. (2004). Investigating factors that influence individual safety behavior at work. *Journal of Safety Research*, 35(13), 275-285.

Mumma, G., Allen, A., & Couvillion, W. (2000). An analysis of selected performance indicators for U.S. ISO 9000 registered agribusiness firm sites. *Journal of Food Distribution*, 31(1), 225-235.

Murphy, D.J. (2003). Human behavior theories, models, and applications. In D.J. Murphy (Ed), *Looking beneath the surface of agricultural safety and health*, (pp. 45-67). St. Joseph, Michigan: American Society of Agricultural Engineers.

Neal, A., Griffin, M.A., & Hart, P.M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, 34(1-3), 99-109.

Newell, B.R., Lagnado, D.A. & Shanks, D.R. (2007). *Straight choices: The psychology of decision making*. New York: Taylor and Francis Group.

Peterson, D. (2000). The barriers to safety excellence. *Occupational Hazards*, 62(12).

Poortinga, W. & Pidgeon, N.F. (2004). Trust, the asymmetry principle, and the role of prior beliefs. *Risk Analysis*, 24(6), 1475-1486.

Pousette, A., Larsson, S. & Torner, M. (2008). Safety climate cross-validation, strength and prediction of safety behavior. *Safety Science*, 46(3), 398-404.

Prussia, G.E., Brown, K.A., & Willis, G.P. (2003). Mental models of safety: Do managers and employees see eye to eye? *Journal of Safety Research*, 33(2), 143-156.

Reason, J., Parker, D. & Lawton, R. (1998). Organizational controls and safety: The varieties of rule-related behavior. *Journal of Occupational and Organizational Psychology*, 71(4), 289-304.

Reed, C.R. (2006). *Managing stored grain to preserve quality and value.* St. Paul, Minnesota: American Association of Cereal Chemistry International.

Rousseau, D.M., Sitkin, S.B., Burt, R.S. Camerer, C. (1998). Not so different after all: A cross-discipline view of trust. *Academy of Management Review*, 23(3), 393-404.

Schweitzer, M.E., Hershey, J.C., & Bradlow, E.T. (2006). Promises and lies: Restoring violated trust. *Organizational Behavior and Human Decision Processes*. 101(1), 1-19

Seo, D-C. (2005). An explicative model of unsafe work behavior. *Safety Science*, 43(3), 187-211.

Seo, D., Torabi, M.R., Blair, E.H., & Ellis, N.T. (2004). A cross-validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research*, 35(4), 427-445.

Sharps, M.J. & Martin, S.S. (2002). "Mindless" decision making as a failure of contextual reasoning. *The Journal of Psychology*, 136(3), 272-282.

Shockley-Zalabak, P., Ellis, K., & Winograd, G. (2000). Organizational trust: What it means, why it matters. *Organization Development Journal*, 18(4), 35-47.

Siegrist, M. & Cvetkovich, G.T. (2001). Better negative than positive? Evidence of a bias for negative information about possible health dangers. *Risk Analysis*, 21(1), 199-206.

Simard, M. & Marchand, A. (1995). A multilevel analysis of organizational factors related to the taking of safety initiatives by work groups. *Safety Science*, 21(2), 113-129.

Simon, H.A. (1955). A behavioral model of rational choice. *Quarterly Journal of Economics*, 69, 99-118.

Simon, H.A. (1956). Rational choice and the structure of environments. *Psychological Review*, 63, 129-138.

Slovic, P. (1993). Perceived risk, trust, and democracy. *Risk Analysis*, 13(6), 675-682.

Sroufe, R. & Curkovic, S. (2008). An examination of ISO 9000:2000 and supply chain quality assurance. *Journal of Operations Management*, 26(4), 503-520.

Thakur, M., Mosher, G.A., Brown, B., Bennet, G.S., Shepherd, H.E., & Hurburgh, C.R. (2009). Traceability in the bulk grain supply chain. *Resource: Engineering and Technology for a Sustainable World*, April/May, 20-22.

Thompson, R., Hilton, T., & Witt, A. (1998). Where the rubber meets the shop floor: A confirmatory model of management influence on workplace safety. *Journal of Safety Research*, 29(1), 15-24.

Tversky, A. &Wakker, P. (1995). Risk attitudes and decision weights. *Econometrica*, 63(6), 1255-1280.

Voigt, J. (2005). Maintaining quality and purity in commercial elevators and equipment. Proceedings of the Grain Elevator and Processing Society (GEAPS). Downloaded on February 23, 2009 from http://www.geaps.com/proceedings/2005/voigt.cfm.

Vredenburgh, A.G. (2002). Organizational safety: Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research*, 33(2), 259-276.

Walker, G. W. (2010). A safety counterculture challenge to a "safety climate". *Safety Science*, 48(3), 333-341.

White, M.P. & Eiser, J.R. (2006). Marginal trust in risk managers: Building and losing trust following decisions under uncertainty. *Risk Analysis,* 26(5), 1187-1203.

White, M.P., Pahl, S., Buehner, M., & Have, A. (2003). Trust in risky messages: The role of prior attitudes. *Risk Analysis*, 23(4), 717-726

Whitener, E.M., Brodt, S.E., Korsgaard, M.A., & Werner, J.M. (1998). Managers as initiators of trust: An exchange relationship framework for understanding managerial trustworthy behavior. *Academy of Management Review*, 23(3), 513-530.

Willemyns, M. Gallois, C. & Callan, V. J. (2003). Trust me, I'm your boss: Trust and power in supervisor-supervisee communication. *International Journal of Human Resource Management*, 14(1), 117-127.

Wilhem, M. (2004). Make a smooth change to TS 16949. *Quality*. 43(8), 40-44.

Wu, T.C., Lui, C.W., & Lu, M.C. (2007). Safety climate in university and college laboratories: Impact of organizational and individual factors. *Journal of Safety Research*, 38(1), 91-102.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology*, 65(1), 96-102.

Zohar, D. (2000). A group-level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology*, 85(4), 587-596.

Zohar, D. (2002). Modifying supervisory practices to improve subunit safety: A leadership-based intervention model. *Journal of Applied Psychology*, 87(1), 156-163.

Zohar, D. (2003). The use of supervisory practices as leverage to improve safety behavior: A cross-level intervention model. *Journal of Safety Research*, 34(5), 567-577.

Zohar, D. & Erev, I. (2007). On the difficulty of promoting workers' safety behavior: Overcoming the underweighting of routine tasks. *International Journal of Risk Assessment and Management*, 7(2), 122-136.

Zohar, D. & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4) 616-628.

Chapter 3. The effect of group and organizational trust on employee safety perceptions and safety decision-making

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ABSTRACT

Introduction: The safety priority perceptions of employees may be affected by several things, including their level of trust in their work group supervisor and organizational management. The level of safety climate is thought to be an important predictor of safe behavior at both organizational and work group tiers. Employee safety behaviors are the result of safety-orientated decision-making. This study builds on the concept of safety decision-making and examines the relationship between perceptions of trust, safety climate and employee decision-making. *Method:* 178 employees of three commercial grain handling facilities completed questionnaires on perceptions of trust and safety climate and participated in a computerized safety decision-making simulation. Descriptive statistics, correlation, and hierarchical regression analysis were used to calculate the relationships between the variables. *Results:* Organizational and group level trust significantly predicted safety climate and the choice of a safer decision. Organizational and group safety climate levels significantly predicted a safer decision choice. Organizational trust showed a significant positive relationship with peer pressure, but no other decision dimension variables exhibited a significant relationship with trust or safety climate. *Impact on Industry:* This study suggests that trust plays a role in safety climate perceptions of employees and further supports previous research proposing a two-level safety climate. Understanding the roles of other influencing factors is important for managers and supervisors who wish to promote safe work behavior for their employees.

PROBLEM

Human factors play an important, but often overlooked, role in the management of safety in the work environment. Workplace safety is one of several competing organizational demands. The relative priority of these demands is formed by perception, based in part on

employee experiences and practices (Das et al., 2008; Zohar & Luria, 2005). One human factor which is believed to influence employees' perception of safety is trust. Although linkages between trust and safety outcomes (Conchie & Donald, 2008; Edmondson, 1996; Vredenburgh, 2002; Whitener et al., 1998) and between safety climate and safety behavior have been explored in past research (Cooper & Phillips, 2004; Johnson, 2007; Thompson, Hilton, & Witt, 1998; Zohar, 2002), little attention has been paid to the linkages of employee trust or safety climate to employee decision-making, an important precursor to employee behavior. Because safe workplaces depend heavily on the decisions employees make on the job (Keren, Mills, Freeman & Shelley, 2009; Zohar & Erev, 2007) an increased understanding of factors influencing employee decision-making processes provides information helpful to the development of specific safety counter measures, best practices for management, or targeted educational intervention.

TRUST AND SAFETY

Trust has been shown by previous safety researchers to clearly play a role in safety related outcomes in the workplace (Burns, Mearns & McGeorge, 2006; Conchie & Burns, 2008; Cox, Jones, & Collinson, 2006). Several positive organizational outcomes have been linked with positive employee trust perceptions, including high quality communication, performance levels, constructive citizenship behaviors, increased problem solving, and employee cooperation (Whitener et al., 1998). Furthermore, the effect of supervisors and management on the safety perceptions of employees has been discussed by many researchers and practitioners (Arboleda et al., 2003; Keren et al., 2009; Petersen, 2000; White & Eiser, 2006; Whitener et al., 1998; Zohar, 2000, 2002; Zohar & Luria, 2005), but none have specifically studied the relationship between trust and safety climate. Although trust has been suggested as a contributing factor in previous studies (Clark, 1999; Conchie & Donald, 2008; Mullen, 2004; Seo, Torabi, Blair, & Ellis, 2004), little research has measured the strength of the relationship between organizational and group-level trust and safety climate.

Although few studies have tested the impact of trust on safety climate, low trust levels have been linked to several negative safety and organizational outcomes. First, a lack of trust in administrators may divert the employees' attention from their assigned tasks (Mayer & Gavin, 2005). Moreover, employees who are concerned or worried about the

behavior of their boss may not be focusing on improving their own work or concentrating on their personal safety. Additional outcomes of low trust work environments may include increased attempts to break management rules or setting inappropriate goals which contradict organizational objectives (Davis et al., 2000). Kath, Magley & Marmet (2010) and Prussia, Brown and Willis (2003) have suggested that settings where positive relationships between managers and employees are evident, a stronger agreement on safety concerns is present and is more likely to predict positive organizational safety outcomes.

Trust has been shown to be particularly important in high reliability organizations. High reliability organizations have been defined as those where safety is a critical component of operations (Cox et al., 2006). This is in part due to the intrinsic hazards of these organizations. Failure in safety systems at this level could lead to high level damage, injury, or loss of life (Cox et al., 2006). Examples from the literature include: aviation, biotechnology, offshore drilling, nuclear, and rail operations.

Even in organizations which do not present the potential for catastrophic hazards, McLain and Jarrell (2007) note that high production and technology demands often can result in mental and physical environments which could threaten organizational safety. Multiple demands on a worker's time, together with a lack of control over work tasks, can blur behavior expectations for workers. Although management requires workers to be both safe and productive, sometimes these two priorities are incompatible, given the work environment (McLain & Jarrell, 2007).

AGRICULTURAL SAFETY

Agriculture is not included on the list of high reliability organizations (Cox et al., 2006) even though work environments within the commercial agricultural handling industry have no shortage of safety hazards. Production agriculture has long been considered a hazardous profession based on the number of safety incidents recorded annually (Chapman & Husberg, 2008; National Safety Council, 2007; U.S. Department of Labor, 2008). Management and supervisory personnel at commercial grain handling facilities deal with a wide variety of safety hazards including confined space concerns, chemical, biological, petroleum and electrical dangers and excessive noise (Lehtola, Brown, & Becker, 2008; OSHA, 1988, 2004; Rains, 2004; Roberts & Field, 2010). Other challenges of agricultural

worksites include the combination of large numbers of seasonal and temporary laborers and the intense pressure for high productivity during the busy spring and fall seasons (Brandon, 2009; Chapman & Husberg, 2008; Lehtola et al., 2008).

On any given day, multiple hazards are presented to workers in the agricultural handling industry. Dangers are well known by workers (Walker, 2010) yet incidents still occur and injuries and fatality rates in the industry are perennially higher than those in other industries (Bureau of Labor Statistics, 2010).

SAFETY CLIMATE

One measurement which is hypothesized to influence organizational climate and serve as a frame of reference for employee behavior is safety climate (Flin, Mearns, O'Connor, & Bryden, 2000; Williamson et al., 1997). Safety climate was introduced by Zohar (1980) as a measurement of shared employee perceptions concerning the relative importance of safety as compared with other organizational goals. To measure and describe the parameters of safety climate, researchers use the terms level and strength. The level of safety climate refers to the perception scores given by workers while the strength reflects the agreement on the level of safety climate. The two do not necessarily exhibit a positive relationship (Keren et al., 2009). Others have defined and discussed factors which predict safety climate (Cooper & Phillips, 2004; Griffin & Neal, 2000; Neal, Griffin, & Hart, 2000; Zohar, 2002), but disagreement on the constructs and dimensions which predict or describe an organization's safety climate remains.

Despite differences among researchers, dominant themes have emerged. One theme which has been revealed repeatedly is the commitment management and supervisors have towards safety (Cavazza & Serpe, 2009; Conchie & Donald, 2008; Neal et al., 2000). While researchers have established the important role management and supervisors play in predicting the strength and level of safety climate (Clarke, 1999; Cooper & Phillips, 2004; Flin et al., 2000; Mullen, 2004; Zohar, 2000, 2002), they have not come to an agreement on specific aspects management and supervisory teams should concentrate on to increase organizational and group level safety.

Cooper and Phillips (2004) characterize the relationship between management and supervisory commitment and safety climate as complex, with changes in climate level and strength not always resulting in more positive safety performance. They cite the use of self-reported safety performance outcomes as a key limitation in measuring the relationship between safety climate and safety performance. Flin et al. (2000) suggest safety climate components and themes vary greatly according to differences in industry, company, and work practices.

A second theme emphasized by safety researchers is the importance of work group attitudes towards safety (Pousette, Larsson & Torner, 2008; Zohar & Luria, 2005). Seo et al. (2004) suggested that management commitment to safety was an influencing factor on supervisor commitment to safety, suggesting a relationship between safety attitudes from the organizational level and the group level.

Zohar and Luria (2005) present a multilevel model of safety climate based on a theoretical framework outlined by Zohar (2000, 2003). The model assumes that employees are continually presented with a large number of inconsistent and conflicting demands from both management and supervisors. A second assumption is that although the management may create policies and regulations, the daily implementation of the resulting actions and tasks on the work floor is left to the supervisors (Zohar, 2000, 2003). Supervisors are often left to interpret management mandates with a great deal of flexibility, resulting in variation between work groups.

In testing their multi-level model of safety climate, Zohar and Luria (2005) found that organizational (management) climate predicts group (supervisory) climate, which in turn predicts worker behavior. The routine of work practices played a role as well, with stronger relationships noted between organizational and group climate when work routines were more structured and formalized. One reason for this observation could be that the greater the routine, the less flexibility supervisors have to interpret the implementation of daily practices and procedures (Zohar & Luria, 2005).

An additional challenge for safety researchers has been validating a predictive relationship between safety climate and safety behaviors. Zohar (2000) and Zohar and Luria (2005) have led work in this area. Johnson (2007) confirmed the predictive validity of Zohar

and Luria's (2005) safety climate survey. Through this survey, both researchers (Johnson, 2007; Zohar & Luria, 2005) were able to confirm a link between safety climate and injury rates with safe behaviors as a mediating effect.

SAFETY BEHAVIOR

Even with these initial relationships confirmed, the predictive power between safety climate and lagging indicators such as self-reported employee behavior, injury rates, accident records, and other indicators has not been shown conclusively (Cooper & Phillips, 2004; Keren et al., 2009). Part of this is because of the inherent limitations of lagging indicators, which only emerge after an incident has occurred. In contrast, leading indicators such as safety climate present themselves prior to a safety event, giving management and supervisors the chance to address negative behaviors or potential risks before they become a problem. Hudson (2009) notes that although leading indicators are often available to managers, many choose to ignore them in favor of higher priority production and financial concerns. Adding to this are data which show that although many unsafe behaviors occur in a day, very few of these result in accidents or injuries (Reason, 1997; Vredenburgh, 2002; Zohar & Erev, 2007). Additionally, most accidents do not have a straightforward cause and effect relationship but are the result of a series of events and interacting factors (Brown, 2000; Choudhry & Fang, 2008; Prussia, Brown & Willis, 2003). All of these factors make prediction of employee safety behavior difficult and limit the predictive power of safety climate when used alone.

Furthermore, Das et al. (2008) note that safety climate has a significant perceptual component. This means employees may recognize and construe information or episodes quite differently and the management and supervisors may have little control over these perceptions. Keren et al. (2009) reiterates this, stating that employees do not respond directly to workplace incidents, but perceive and interpret events which occur in their work environment before taking action.

Clark (1999) found organizational perceptions of workers, supervisors, and managers to be positive overall, but noted a lack of understanding and incorrect perceptions among groups. Negative or incorrect perceptions may incorrectly influence group beliefs about other work expectations. Because perceptions are not necessarily based on fact, but rather the

employees' interpretation of facts, correct information about group safety perceptions is important information for managers and supervisors (Clark & Payne, 1997). Prior beliefs, employee attitudes, and individual differences have also been shown to affect employee perceptions (Henning et al., 2009; Poortinga & Pidgeon, 2004).

SAFETY DECISION-MAKING

Keren et al. (2009) established a framework for studying the relationship between safety climate and safety decision-making, with the decision choice representing proximate behavior. The concept is defined by factors which are thought to play a role in the safety-related decisions employees make on the job, termed dimensions. The safety decision-making task explored in the present research addresses a scenario of personal risk.

Amendola (2001) summarizes decision making under risk as a three step process: establish probability and degree of the hazard, assess the benefits and costs, and establish priorities so that the greatest benefits can be realized at the lowest cost. Amendola's decision making paradigm does not specifically address safety, but many of its features are applicable in a safety environment. When making risky decisions (often the case with safety-related decisions), Slovic (1993) asserts that the decision making process may not follow a rational pattern, and therefore, may not conform to any standard decision making theories.

Even so, several psychological theories have been offered to explain a worker's decision-making process under risky conditions. Murphy (2003) applies a model similar to Amendola's in an agricultural safety setting. The model involves four steps: assessing the problem, identification of risks (hazards), evaluating what works in addressing the problem, and a final implementation step. He links the approach to traditional models developed in the public health sector, where the overriding goal is behavior change. The approach goes beyond a one-time decision, and this philosophy must be true for enduring occupational safety. Murphy (2003) notes the Theory of Planned Behavior is one of many behavioral models that can be applied to safety. The Theory of Planned Behavior posits that behavioral intentions immediately precede behavior. People will follow their intended action if the said behavior will lead to a desirable outcome, if others value the behavior, and if necessary resources and opportunities are available to support the behavior (Murphy, 2003).

Another position on the Theory of Planned Behavior is offered by Fogarty and Shaw (2010) and this examines human error. Psychologists differentiate simple errors (defined as unintentional) from violations, where employees willfully disregard safety procedures. Fogarty and Shaw (2010) argue that safety violations are explained by the psychological Theory of Planned Behavior. In a safety context, the Theory of Planned Behavior is based on the idea that a person's behavior is a direct result of both their intentions and their perceived behavioral control. In turn, intentions are shaped by attitudes, subjective norms, and perceived behavioral control. In a work environment, subjective norms are perceived by employees based on behaviors and expectations of managers, supervisors, and co-workers while a person's prominent beliefs form the basis for many of their attitudes. Perceived behavioral control is rooted in behavior intentions, based on the individual's perception of the ease or difficulty of performing a specific behavior. The model constructed by Fogarty and Shaw (2010) included variables of management attitude, self-attitude, group norms, workplace pressures, the intention of the employee to violate the safety procedure, and the actual violations and all variables were found to be significant, accounting for a large proportion of variance in both intent to violate and violations.

Traditionally, a fundamental basis for risky decision-making has been the Expected Utility Theory (EUT) which posits that when people make risky decisions, they weigh several options and the likelihood of each occurring (Newell, Lagnado & Shanks, 2007; Zohar & Erev, 2007). The option with the highest "utility" to the decision-maker is selected as the final decision choice. However, the process is not always so straightforward. When comparing benefits between safe behaviors and unsafe behaviors under the framework of the EUT, unsafe behaviors are clearly favorable to the employee in terms of effort and time expended (Zohar & Erev, 2007), even though the decision choices are obviously unsafe and therefore, have a lower utility to the decision-maker. The choice of an unsafe alternative also refutes the long held assumption that self-preservation outweighs other employee motivations (Maslow, 1970).

A variety of violations to the EUT have been noted by researchers over the years, with three noted by Newell et al. (2007). Researchers have doubted the ability of humans to act rationally when making decisions, due in part to limitations in cognitive processing and

availability of information. Notably, Herbert Simon (1955, 1956) redefined the human decision-making process as one which took advantage of the restricted information and cognitive resources to make a decision that was "good enough" rather than ideal in terms of utility.

A second criticism of EUT in decision-making was offered by Edwards (1968) and Tversky & Kahneman (1974). They proposed that decision-making behavior used mathematical principles such as probability and probabilistic judgment, expanding the possibilities of information acquired and how it was used before a decision was made (Newell et al., 2007). The research served as a basis for the use of Bayes' theorem and the bias and heuristic approach in decision-making research.

The final violation noted by Newell et al (2007) concerning the EUT refines the role of choice. Best represented by the Prospect Theory (PT) (Kahneman & Tversky, 1979), the theory posits that although humans attempt to make decisions maximizing their utility, both decision utility and probability are subject to cognitive distortions in the decision-making process. Although researchers have documented many violations and weaknesses to the EUT, the theory still plays a large role in theoretically describing the decision-making process under risky conditions.

PT challenges the fundamental postulation of the EUT by suggesting that people tend to overweight low-probabilities and underweight higher-probabilities – an example of the "distortions" introduced under the framework of the EUT (Tversky & Wakker, 1995). This theory also states that when a person stands to gain, risk adverse behavior is more common while those who perceive that they have nothing to lose exhibit more risk-seeking behavior. Newell et al. (2007) state that actual probabilities are often ignored by decision makers who underestimate common outcomes and overestimate rare outcomes. Additionally, Kahneman and Tversky, (1979) demonstrated that decision-makers can be more affected by decision outcomes that have a lower probability of actually occurring but more impact rather than those that have a stronger chance of happening but with a lower or uncertain impact. Both the EUT and Prospect Theory imply that people are more sensitive to risk than uncertainty.

Zohar and Erev (2007) offer three behavioral propensities that may explain an employee's willingness to behave in an unsafe manner. First as shown by Kahneman and

Tversky (1979), people tend to underweight future outcomes of unsafe behavior, especially if the outcome does not become evident immediately, such as when using personal protective equipment or exposure to extreme noise. A second behavioral inclination is to overlook the potential injury hazard of unsafe behaviors – in part because few of these unsafe behaviors actually result in injuries or fatalities. Reason (1997) and Heinrich (1931) estimated an injury or fatality rate of less than 1% for each safety violation (Zohar & Erev, 2007).

Finally, an employee's decision can be classified by one of two types of outcomes. Internal outcomes are those which affect only the decision maker. Externalities are outcomes which affect other people. Zohar and Erev (2007) theorize that in the case of unsafe behavior, the externalities of the decision are typically underweighted by the decision maker in favor of positive internal outcomes such as savings in time and effort and an increase in productivity. In all these situations, the expected utility of unsafe decisions is clearly favorable to the utility of safe decisions (Keren et al, 2009). However, the hypothesis of researchers is that organizational factors have the potential to sway the balance of the utility for safe and unsafe decisions (Brown et al., 2000; Edmondson, 1996; Johnson, 2007; Neal et al., 2000; Seo, 2005; Zohar & Luria, 2005). It is this hypothesis which is explored in the present research.

Another factor which affects the utility of a decision and adds distortion to the decision process is the presence of or lack of pertinent information. Sharps and Martin (2002) propose that information retrieved to support positive decisions must be immediately accessible for it to be used. Even if applicable information is available in long term memory, books, manuals, or hard drives, information that is not seen at the time of the decision may have very little effect on the decision choice. In a safety environment, the practicality and possibility of having immediately accessible information for all potential unsafe actions is questionable if not impossible. Sharps and Martin's (2002) calls into question the fundamental assumption of educational intervention and training.

MEASURING EMPLOYEE DECISION-MAKING

In this project, decision scenarios were presented to participants using Decision Mind™, a software platform using the decision process tracing method. Decision process tracing is an approach used to capture direct cognitive processes by evaluating the information an individual uses to form a judgment and the sequence with which the

information was examined (Ford et al., 1989). Other key processes recorded include: the number of alternatives viewed, the time needed to make a choice, and the final decision. A key advantage of process tracing is that it addresses the intervening steps between information acquisition and decision choice, considered a fundamental component of decision-making analysis (Mintz, 2004).

Decision process tracing has several key advantages over self-reported questionnaires, which depend on recall ability and researcher observation of work behavior, which is cross-sectional at best and may have serious bias related to the Hawthorne and other effects. Decision process tracing also has benefits not realized with structural modeling. The process tracing focuses on the processes humans use to analyze and gather information in preparation to make a decision choice while the structural modeling emphasizes the final decision choice (Ford et al., 1989). Mintz (2004) adds another strength of the process tracing methodology – the ability to isolate decision rules and models used in the decision-making process as well as test the association of situational and personal factors with the decision process and the final decision choice. For these reasons, decision process tracing was utilized to study decision-making for the present study.

METHODOLOGY AND MEASURES

This research seeks to better understand the relationship between employee perceptions of trust and safety at two levels of administration – organizational (management) and group (supervisory). A second goal of the research is to link these perceptions to employee safety decision-making choices and to the information employees use to make their final decision in an agricultural handling and storage facility.

Three instruments were used to measure the test variables: 1) a two-level questionnaire measuring behavioral workplace trust, 2) a two-level safety climate questionnaire, and 3) a computerized decision-making simulator. Perceptions of trust and safety climate were measured at two levels based on previous work by Zohar (2000, 2008). His research has suggested that although employees may informally communicate with their supervisor daily, communication with management is typically limited to more formal and less frequent exchanges. As a result of this, perceptions of the management and supervisors

by employees may be very different. Moreover, Zohar (2008) believes that while the management team may create and promote the organization's policies and procedures, it is the supervisors that actually implement and interpret these policies. In this research, perceptions of management were classified as organizational level while supervisor perceptions were described as group level.

The Management Behavior Climate Assessment (Levin, 1999) was used to evaluate employee trust levels in their management and their supervisor as well as provide demographic data such as age, gender, and length of time with the organization. The 40 item instrument (20 items measuring perceptions of management and 20 items measuring perceptions of supervisors) was developed and validated by Levin (1999) as a behavioral measurement of trust in top level and executive level (supervisory) management. Variables were measured on a 5 point scale (1 = Almost or almost always; 2 = Usually; 3 = Occasionally; 4 = Seldom; and 5 = Rarely or never). Examples of items used included "top management tells the same story to each person they speak to" and "my supervisor does what he or she says they will do". Levin (1999) identified two factors to explain the concept of trust: consistency and credibility. Confirmatory factor analysis performed on data gathered for this project yielded similar results. Therefore, the aggregated means of employee responses regarding trust, consistency, and credibility are included in the model as the dependent variable.

To measure employee perceptions of safety climate, the Organization and Group Level Safety Climate instrument (Zohar & Luria, 2005) was used. The instrument consisted of 32 items and surveyed employees on two levels: organizational (management) and group (supervisory). Items were scored on a 5 point scale (1 = Strongly agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly disagree).Examples of items used include "top management react quickly to solve problems when told about safety hazards" and "my supervisor emphasizes safety procedures when we are working under pressure". Factor analysis yielded one universal safety climate factor for management (organizational) and one for supervisors (group), therefore, aggregated scores for employee perceptions of organizational and group safety climate are used in analysis. Although the scale originally

used a three factor climate structure, the one factor climate structure has been suggested by others as adequate (Johnson, 2007; Zohar & Luria, 2005).

The second portion of the study measured employee decision making patterns. The safety decision scenario was created based on a fundamental safety concern in all work environments – the failure to follow standard operating procedures (SOPs) (Keren et al., 2009; Zohar & Erev, 2007). The scenario was selected to reflect the response of an employee when he or she was presented a potential shortcut opportunity. The dilemma presented occurs commonly in the grain handling industry – the bridging of out of condition grain as it is unloaded from a grain storage container to a transportation vehicle (Brandon, 2009; Freeman, Kelley, Maier, and Field, 1998; Kingman & Field, 2005). The bridge blocks the flow of the grain and slows or stops the grain from moving.

Following SOPs will resolve the issue, but require additional time, slowing productivity and delaying shipments to clients. Fixing the problem quickly presents a major engulfment hazard to the employee. The dilemma presented to the employee asks him or her to decide whether to follow safety procedures and take additional time or fix the problem quickly but with an increased risk of injury or death.

The decision-making scenario facilitated use of the process-tracing method. This technique traces the information gathering process by recording data on the information viewed by the employee during a decision task. Data collected can then be used to infer information on the decision-making process used by employees as they make a choice (Ford et al., 1989; Keren et al., 2009; Payne et al., 1993).

The software platform used was Decision Mind™, a computerized decision-making simulation (Mintz, 2004). The decision structure is presented in a matrix format as shown in Table 1 with a set of alternatives and a set of dimensions. Alternatives define the choices available to the participant (C) and information is gathered by viewing the dimensions (D). Each square of the matrix (V) provides an evaluation of a given choice on a given dimension. The participant is asked to choose one alternative based on information acquired on the dimensions. Each square on the matrix is also assigned a numeric utility value on a scale from -10 to +10, with -10 indicating a negative evaluation and +10 a positive evaluation. The utility values represent the impact of the alternative within that specific dimension.

Table 1. Decision Mind$^{\text{TM}}$ Decision Simulation Matrix

	C_1	C_2	C_3	C_4
D_1	V_{11}	V_{21}	V_{31}	V_{41}
D_2	V_{12}	V_{22}	V_{32}	V_{42}
D_3	V_{13}	V_{23}	V_{33}	V_{43}
D_4	V_{14}	V_{24}	V_{34}	V_{44}

The decision-making scenario was developed and critiqued by a panel of experts in grain elevator operations using a modified Delphi method (Linstone & Turoff, 2002). Weighted scores were assigned by the same panel of experts. Using the information contained within the matrix squares, employees viewed the information and then selected a decision choice. Scenarios were pilot tested on a small group with a moderate knowledge of grain elevator operations. Slight modifications were made to improve the clarity of survey instruments and the decision scenarios as a result of the pilot tests. The text of the scenario presented and the alternatives and dimensions are shown below. The matrix with outcomes and utility values is shown in the appendix. The text of the decision simulation was presented as follows:

> *You and a co-worker are emptying a bin and working to fill a waiting truck. Your supervisor walks by to check on your progress and notices the flow of grain to the truck has slowed. Your supervisor suggests keeping the auger running while someone gets inside the bin to release the blockage and keep the grain flowing. You are surprised because your organization normally follows the grain safety handling standard administered by OSHA, which require lock out / tag out of the bin before entry. You need to decide what to do next. You have the following four options.*
>
> *1. Enter the bin*
> *2. Follow entrance procedure*
> *3. Confront supervisor, follow procedure*
> *4. Follow procedure and report supervisor*
>
> *These four factors could impact your decision:*
>
> *1. Safety*
> *2. Productivity*
> *3. Supervisor's opinion of you*
> *4. Peer pressure*

When you are ready, follow the steps below in order to initiate and complete the simulation

CALCULATIONS AND VARIABLES

The dependent variables included the two measures of organizational and group trust and the two measures of organizational and group safety climate. The dependent variables are the aggregated mean of the individual participant scores for the level of trust variables (including trust, consistency, and credibility) in management and supervisory personnel and the aggregated mean of the individual participant scores for the level of safety climate for management and supervisory personnel.

The independent variables are the final choice made by each participant and the search index, as presented below. To provide a way to quantitatively present the information gathering process completed by participants, Keren, Freeman, and Schwab (2006) introduced the search index metric. The measurement calculates the ratio between the number of times information squares of one dimension have been reviewed as compared with the other dimensions. In this study, four dimensions were measured: Safety, Productivity, Supervisor Opinion, and Peer Pressure. Accordingly, the search indices are the Safety Search Index (S_SI), Productivity Search Index (P_SI), Supervisor Opinion Search Index (SO_SI), and Peer Pressure Search Index (PP_SI). Calculations are shown below.

$$S\_SI = \frac{N_{Safety}}{\frac{1}{n}\sum_{i=1, i \neq Safety}^{n} N_i} \tag{1}$$

Where N_{safety} denotes the number of times safety squares were viewed, and n denotes the number of times squares other than safety were viewed.

$$P\_SI = \frac{N_{Productivity}}{\frac{1}{n}\sum_{i=1, i \neq Productivity}^{n} N_i} \tag{2}$$

Where $N_{productivity}$ denotes the number of times productivity squares were viewed, and n denotes the number of times squares other than safety were viewed.

$$SO\_SI = \frac{N_{SO}}{\frac{1}{n}\sum_{i=1,i\neq Supervisor\ Opinion}^{n} N_i} \tag{3}$$

Where N_{SO} denotes the number of times supervisor's opinion squares were viewed, and n denotes the number of times squares other than supervisor opinion were viewed.

$$PP\_SI = \frac{N_{PP}}{\frac{1}{n}\sum_{i=1,i\neq Peer\ pressure}^{n} N_i} \tag{4}$$

Where N_{pp} denotes the number of times peer pressure squares were viewed, and n denotes the number of times squares other than peer pressure were viewed.

Index values which equal one indicate the dimension has equal importance to others in the decision-making process. Values less than or greater than one represent a dimension of less importance as compared with others or greater importance in relation to others, respectively. Values of one denote the dimension plays no more importance than any of the other dimensions; therefore, it is designated as the "ultimate mean". In this study, four dimensions were used: safety, productivity, supervisor's opinion, and peer pressure. The orientation most affiliated with safety in this decision-making scenario is the safety index. Employees who viewed safety dimensions at a higher frequency were assumed to be considering safety as a prioritized source of information in their decision process. Consequently, they were of greater interest to researchers.

HYPOTHESES

The hypotheses of this work focused on the relationship between employee perceptions of trust and safety and less on the constructs and factors making up these perceptions. For this reason, the hypotheses emphasize the association between the final decision choice and decision process and the climate variables. The study aimed to test the following null hypotheses:

H1. The level of organizational trust does not predict the level of organizational safety climate.

H2. The level of organizational trust does not predict the choice of a safer decision in a safety decision-making task.

H3. The level of organizational trust does not predict a higher orientation to safety information in a safety decision-making task.

H4. The level of organizational safety climate does not predict the choice of a safer decision in a safety decision-making task.

H5. The level of organizational safety climate does not predict a higher orientation to safety information in a decision-making task.

H6. The level of group trust does not predict the level of group safety climate.

H7. The level of group trust does not predict the choice of a safer decision in a safety decision-making task.

H8. The level of group trust does not predict a higher orientation to safety information in a safety decision-making task.

H9. The level of group safety climate does not predict the choice of a safer decision in a safety decision-making task.

H10. The level of group safety climate does not predict a higher orientation to safety information in a safety decision-making task.

H11. The safety search index value does not differ significantly from the ultimate mean of 1.

The perception instruments and decision simulations were both presented to employees in a web-based format. The decision simulations were offered on the Decision Mind™ platform and the trust and safety perception instruments were administered using Survey Monkey. The data collection process began with a letter of consent, followed by the trust and safety questionnaires. Questionnaires were presented in random order and questionnaire items were also randomized. The decision simulation was presented once perception questionnaires were completed. Employees were able to complete the steps of the process at different times as their schedule allowed. To connect data from instrument to instrument, employees were given a set of three identification numbers. No personal identifiers were linked with the identification numbers to eliminate the possibility of tracking participants' responses.

Participants were employees of three Midwestern grain handling facilities. Employees who would be subject to safety-related decisions in their daily jobs (i.e. those who worked clerical and administration were excluded) were offered the opportunity to participate in the project. Of the 410 invitations, 197 responded. Of these 197, 178 provided usable data, for a response rate of 43 percent. Employees were drawn from grain handling organizations which volunteered for the study. Although only three companies made up the sample, the service area of these three covered nearly one-third of the state's area. Additionally, because a required condition of participation in this study was a two-level administrative system, the grain handling capacities for all three were large, varying between 18 million bushels and 217 million bushels per year. According to capacity data provided by the each grain elevator and from the state Department of Agriculture, the aggregated handling capability of the three (approximately 58.3 million bushels of grain handled per year) makes up roughly 20% of the state's grain handling capacity in an average year. Data were collected from March until May of 2010. Mean responses from all organizations were measured to rule out significant effects from one company in the sample. No significant differences were found between companies in any of the variables so data from all three were aggregated for analysis.

Results were calculated using Statistical Package for the Social Sciences (SPSS 18.0). Demographic information on the sample and a correlation matrix of bivariate correlations for organization and group level variables are presented first. The distributions of decision choices and mean comparison of search indices are presented next. To determine which factors were significant predictors of the dependent variables, hierarchical regression analysis was used (Cramer, 2003). The process of hierarchical regression is used to determine the variance explained by certain variables when other influencing factors are controlled. The order by which variables are entered is controlled by the researcher.

For this analysis, the independent variables were entered one at a time, and other independent variables were controlled as each new variable was entered. In this study, the variance in the dependent variables (trust, consistency, and credibility) due to safety climate, safety decision choice, and safety decision dimensions of safety, productivity, supervisor's opinion, and peer pressure are of interest. The explained variance in safety climate due to safety decision choice and the decision dimensions of safety, productivity, productivity,

supervisor's opinion, and peer pressure are also of interest in this study. Both sets of models were calculated at two tiers of administration: organizational (management) and group (supervisory).

<div align="center">RESULTS</div>

Demographic information on the sample and bivariate correlations for organizational and group variables are presented first. Next, the distribution of decision choices and search indices are presented. To determine which factors were significant predictors of the dependent variables, hierarchical regression analysis was used.

The sample contained 142 males and 35 females for a total sample size of 177. The age of participants ranged from below 21 to over 61, with the most common response being 41-50 years of age. Two groups of employees made up the largest portion of the sample – those with less than three years on the job, (38.5%) and those who had been with the organization more than 10 years (34%). Nearly all (98%) had completed high school, with some (62%) completing at least some college.

To observe relationships between variables and guide regression analysis, bivariate two-tailed correlations were calculated for each of the organizational level variables. The correlation matrix is shown in Table 2. Values in parentheses represent scale reliabilities as calculated by Alpha's Cronbach where relevant. Significant relationships between search indices are expected because a single search index is not independent of the others (Keren et al., 2006). When one index is emphasized, the others would be expected to have less emphasis, leading to the appearance of a negative significant correlation.

Table 2. Organizational Descriptive Statistics and Bivariate Correlations[a]

Variable[a]	1	2	3	4	5	6	7
Trust	1 (0.96)						
Safety Climate	.488**	1(0.95)					
Safety Decision	-.205**	-.219**	1				
Safety Index	-.103	-.037	.155	1			
Productivity Index	.144	.121	-.075	.011	1		
Supervisor Opinion Index	-.039	-.082	.005	-.292**	-.253**	1	
Peer Pressure Index	.149*	.031	-.119	-.301**	-.182*	-.137	1

[a]$n = 178$; **$p \leq 0.01$; *$p \leq 0.05$

Two-tailed bivariate correlations were also calculated for group variables. Table 3 presents the correlation matrix for these variables. Scale reliabilities were calculated with Alpha's Cronbach and these values are shown in parentheses, where relevant. Again, search indices are showing a negative significant relationship, but this is due to a lack of independence between search indices rather than because of a suggested relationship.

Table 3. Group Descriptive Statistics and Bivariate Correlations

Variable[a]	1	2	3	4	5	6	7
Trust	1(0.97)						
Safety Climate	.456**	1(0.97)					
Safety Decision	-.327**	-.185*	1				
Safety Index	-.102	.012	.155	1			
Productivity Index	.070	.118	-.075	-.245**	1		
Supervisor Opinion Index	.008	-.138	.005	-.292**	-.253**	1	
Peer Pressure Index	.0070	.080	-.119	-.301**	-.182*	-.137	1

[a]$n = 178$; **$p \leq 0.01$; *$p \leq 0.05$

The second component of data collection was the decision-making scenario. Information from the safety decision-making simulation contains two important data points: the final decision choice and information about the decision-making process. The decision-making process is represented by the search index values, which reflect the information

acquired by respondents in each dimension as compared with the other three dimensions. A value of 1 for a particular dimension indicates that no emphasis was given to that dimension above the others and therefore, represents the ultimate mean or benchmark. A paired sample t-test was performed on each search index to compare its value with 1. T-test values for each index are presented in Table 4.

Table 4. T-test values for information emphasis within a safety decision-making task[a]

Search Index	Mean	S.D.	t score	P-level
Safety	1.34	1.40	3.29	0.001
Productivity	0.967	0.866	-0.526	0.600
Supervisor's Opinion	1.13	1.32	1.28	0.201
Peer Pressure	0.978	0.911	-0.318	0.751

[a]n=177

Two dimensions were higher than 1, but only one of these, safety, was significantly higher than 1. The dimension of supervisor's opinion was higher than one but not in a statistically significant way. The dimensions of productivity and peer pressure were given less than average emphasis by respondents, but the difference was not significant. The second data point contained within the decision-making simulation was the distribution of decision choices. These results are displayed in Figure 1.Numbers on top of each decision choice represent the utility value of that specific decision choice in the safety search dimension.

Figure 1. Distribution of frequency of decision choices in a safety decision-making task[a]
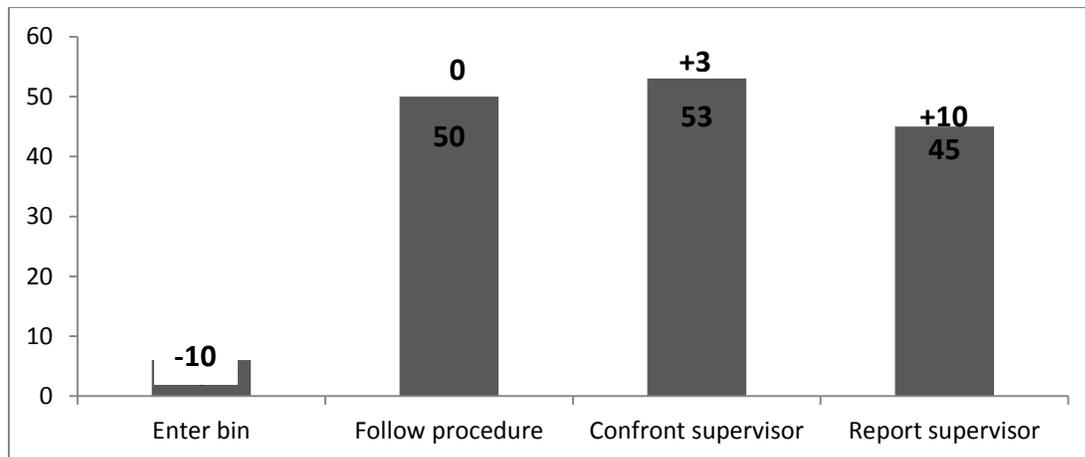
[a]n=160

To measure how well the independent variables of safety climate level, safety decision choice, and the search indices of safety, productivity, supervisor's opinion, and peer pressure explain the variance in the dependent variables, four regression models were estimated at each administrative tier. Three models used the trust factors as the dependent variable (i.e. trust, consistency, and credibility) and independent variables of safety climate level, decision choice, and the four decision indices. Variables were added individually to the model. The fourth model used the level of safety climate as the dependent variable and safety decision choice and the search indices.

Linear hierarchical regression techniques were used on all models to determine which variables could explain a significant amount of variance in the dependent variable. To calculate the proportion of variance explained by the independent variables of the model, standardized regression coefficients (r) and the coefficient of determination (r^2) were calculated. The F test was used to determine if a statistically significant proportion of variance could be explained as each independent variable was entered into the model. Safety decision choices were reverse coded, with positive decisions having higher values, so negative relationships between decision choice and the trust and climate variables are desirable. The summary of the models from the organizational tier are shown in Table 5.

Table 5. Summary of organizational hierarchical regression models[a,b]

Independent variables	Model 1	Model 2	Model 3	Model 4
	Organizational trust[b]	Organizational consistency[b]	Organizational credibility[b]	Organizational safety climate[b]
Organizational safety climate	[c]0.436**	0.377**	0.375**	------
Safety decision choice	-0.084	-0.075	-0.099	-0.203*
Safety index	0.028	0.041	0.046	-0.019
Productivity index	0.110	0.075	0.124	0.084
Supervisor opinion index	0.052	0.020	0.044	-0.052
Peer pressure index	0.181*	0.198*	0.200*	0.055
r^2	0.264	0.210	0.224	0.062
Adjusted r^2	0.236	0.179	0.193	0.032
F	9.164**	6.789**	7.344**	2.048

Group models were created in the same way as those at the organizational level, with group trust, consistency, and credibility as the dependent variables and group safety climate level, quality decision choice, and the search indices as independent variables in the first three models. The final model used group safety climate level as the dependent variable and decision choice and the search indices as independent variables. As with the organizational models, standardized regression coefficients (r), the coefficient of determination (r^2) and the F-test were used to test whether the incremental variance explained by each variable added to the model was statistically significant. Group models are summarized in Table 6.

Table 6. Summary of group hierarchical regression models[a]

Independent variables	Group trust[b]	Group consistency[b]	Group credibility[b]	Group safety climate[b]
Group safety climate	[c]0.387**	0.362**	0.395**	----
Safety decision choice	-0.244**	-0.240**	-0.211**	-0.175*
Safety index	-0.069	-0.072	-0.063	0.061
Productivity index	-0.010	-0.023	-0.026	0.087
Supervisor opinion index	0.031	0.031	0.022	-0.065
Peer pressure index	0.012	0.016	0.047	0.108
r^2	0.255	0.232	0.247	0.058
Adjusted r^2	0.226	0.207	0.217	0.027
F	8.719**	7.70**	8.345**	1.894

DISCUSSION

Several significant findings emerged from this study. Discussion of data will be presented in terms of the hypothesis tested. A major portion of this work measured the final decision choice of employees and these data will be discussed first. Four decision alternatives were offered to employees. With the exception of the small number (n=6) who chose to enter the bin, the frequency distribution of the other three options were nearly equal. Clearly, choice one (enter bin) is not a safe choice, and therefore, a negative choice from a safety perspective. Yet, both dimensions could be evaluated more positively in terms of the

productivity and supervisor opinion. In the decision-making scenario, peer pressure was framed to be a positive influence on safety rather than a negative effect. As expected, few employees chose the most unsafe option – to enter the bin. However, the fact that any of the respondents made this choice further supports the continuing importance of studying employee's safety behavior (Brown, 2000; Hudson, 2009) – even when hazards are presented very clearly, employees still make unsafe decisions (Walker, 2010).

The other three alternatives presented in the decision-making scenario, while safer than the first decision, are not equal in terms of group and organizational safety. Choosing to follow the correct procedure does not target the issue of the supervisor asking the worker to break the SOP; therefore, it does not actually address the root cause of the problem. Confronting the supervisor, while a safe individual decision alternative, could have negative implications for future safety outcomes, especially considering that organizational and group safety often depend on teamwork and psychological safety – the freedom of workers to correct mistakes or incorrect orders (Das et al., 2008; Edmondson, 1996; Kath et al., 2010). Upsetting the supervisor or threatening the power structure of the work group has potentially negative implications. Additionally, this choice could negatively impact the trust between the supervisor and the employee, leading to future unsafe behaviors performed in retaliation by the employee (Davis et al., 2000).

The fourth choice has the best potential to improve safety outcomes in both the group and the organizational level. If supervisors are routinely advising workers to take safety shortcuts, this is a fact management should be aware of. The strong relationships noted between organizational trust and organizational safety climate, suggest the management would be supportive of employees reporting habitual safety offenders. Of course, if management took no action on the employee complaint, the decision to report the supervisor would likely not occur again, in part because of the lack of action by management to address the problem (Zohar, 2000; Zohar & Luria, 2005).

To determine the information employees used to make their decision choice, the search index was utilized as introduced by Keren et al. (2006). Search indices for four search dimensions – safety, productivity, supervisor opinion, and peer pressure – were compared with the mean of 1. A search index equaling 1 would indicate that no higher emphasis was

placed on a given dimension. Of the four search dimensions, only the dimension of safety was viewed by employees significantly more often than the mean. Therefore, hypothesis 11, which posited that no difference existed between the safety search index and 1, was rejected.

Although employees emphasized safety in their information processing, this does not necessarily mean that safety played a significant role in decision choice, especially when other variables such as trust and safety perceptions were entered into the regression model. None of the other search dimensions showed a significant difference from 1, therefore, a conclusion can be made that the dimensions of productivity, supervisor's opinion, and peer pressure, were not prioritized at higher or lower amounts than other dimensions included in the decision-making scenario.

Organizational data revealed several patterns, some expected and some unexpected. The strong relationships between the organizational trust variables and safety climate at the organizational tier are noteworthy, indicating that more positive perceptions of organizational trust, consistency, and credibility predicted a more positive opinion concerning organizational safety climate. Therefore, Hypothesis 1 was rejected.

The finding provides empirical basis for a relationship that many researchers (Clark, 1999; Mayer & Gavin, 2005; McLain & Jarrell, 2007) have implied and supports similar findings by Kath et al. (2010). Based on these data, the perception of consistent and credible behaviors by management predicts a high level of organizational safety climate, but the composite score of trust perceptions explains a higher degree of variance in the model. This finding is not unexpected, as other researchers have theorized that trust is a fundamental component to dedicated and fulfilled employees (Kath et al., 2010). This highly engaged workforce could hypothetically lead to positive behavioral actions, including cooperation, teamwork, and high quality communication (Dirks & Ferrin, 2002; Kramer, 2006).

Hypothesis 2 asked if trust, consistency, and credibility could significantly predict the choice of a safer decision. Hypothesis 3 tested whether trust, consistency, and credibility could predict an increased orientation to safety during the decision-making process. Organizational trust, consistency, and credibility were not found to significantly predict the choice of a safer decision in the regression model, failing to reject Hypothesis 2. Furthermore, the organizational trust variables could not significantly predict an increased

emphasis on safety as employees completed the decision-making process, failing to reject Hypothesis 3. Peer pressure was the sole dimension in the hierarchical model to demonstrate significance (p-value = 0.027). The relationship was positive, indicating that higher levels of trust, consistency, and credibility increase the emphasis on peer pressure. It is important to note that in the decision-making scenario, peer pressure was framed as a positive influence on safety. Although peer pressure can have a positive or negative effect on safety, it is typically the negative pressure from peers highlighted in published research (Keren et al., 2009; Mullen, 2004).

The employees making up this sample seem to defy Mullen's (2004) conclusion that peer pressure can serve as an indirect discouragement to safety by way of the employee's "image". It seems reasonable that positive peer pressure would prevent employees from taking unsafe risks to impress supervisors or co-workers as reported by Choudhry and Fang (2008). Zohar and Erev (2007) suggest that behaviors such as these can be encouraged or discouraged depending on the behavior of management. Although the conclusion from data collected for this project implies that positive management perceptions may lead to positive peer pressure, a significant relationship with a safer decision choice was not noted. With a positive perception of trust and trust constructs and a positive framing of peer pressure, the relationship is not unreasonable.   However, employees were unaware of the frame of the peer pressure dimension when they began the decision-making scenario. Hypothetically, if employees felt positively about organizational trust levels, they may have trusted the management to back them up against peer pressure which is negatively aligned with organizational safety, potentially accounting for employees' initial selection of information on peer pressure.

Peer pressure was also a dimension of interest for Keren et al. (2009) but peer pressure was framed as a threat to safety in the decision-making scenario rather than as a positive effect. An additional unexpected point is that the observed relationship between trust variables and peer pressure showed significance only at the organizational level. Theory posits that organizational climates have much less bearing on peer pressure than group climate (Zohar & Luria, 2005; Zohar, 2003). The fact that peer pressure is even a significant dimension in employee decision-making is also an unexpected finding, given the

individualistic nature of the United States (Keren et al., 2009). The influence of organizational trust perception on the dimension of peer pressure in employee behavior and decision-making clearly warrants additional examination by safety researchers.

Hypotheses 4 and 5 concerned the relationship of organizational safety climate with the choice of safer decision and an increased orientation toward safety in the decision-making process. Organizational safety climate did show a significant positive relationship with the choice of a safer decision, rejecting Hypothesis 4. Although the relationship between the two variables was significant, the incremental variance was not enough to significantly impact the model as demonstrated by the non-significant F value in Table 5. Results from the search indices failed to reject Hypotheses 5, meaning that the level of safety climate did not predict a higher orientation toward safety in the decision-process. Unlike the organizational trust model, none of the other search indices were identified as significant.

These findings make theoretical and logical sense. Employee's sense of the relative importance of safety would theoretically impact their choice of decision. This could be explained partially by their interpretations of the value of safety within the organization. As Zohar and Luria (2005) imply, when employees are faced with competing demands, they will choose the behavior that is perceived to be the highest priority. If safety climate can be interpreted as reflective of an organization's commitment to safety, a high level of safety climate would likely predict more positive safety decision-making by employees. Although past work has found positive associations between safety climate and safety-related events (Evans, Michael, Wiedenbeck, & Ray, 2005; Michael, Evans, Jansen, & Haight, 2005) and safe job-related behaviors (Kath et al., 2010), this finding is one of the few to link levels of organizational safety climate with the choice of safer decisions by employees (Keren et al., 2009).

Hypotheses 6 through 8 evaluated the influence of group tier trust, consistency, and credibility on group safety climate, safer decision choices, and a higher degree of safety orientation in the decision-making process. Group trust significantly predicted more positive perceptions of group safety climate and the selection of a safer decision choice. Thus, Hypotheses 6 and 7 were rejected. Hypothesis 8, testing the relationship of group trust and a

higher orientation to safety during decision-making, did not show a significant relationship, therefore, the conclusion was a failure to reject this null hypothesis.

Hypotheses 9 and 10 tested in the effect of group safety climate on employee safety decision choices and whether they were more likely to use safety-related information to make their decision choice. Group safety climate showed a significant prediction with safety decision choice, indicating that more positive perceptions concerning safety climate predicted the selection of a safer decision choice. Thus, hypothesis 9 was rejected. Because no search indices were identified as having a significant relationship with group safety climate, the data failed to reject the null hypothesis in this case.

The outcome of these findings align with the Zohar and Luria's (2005) two-level climate theory, which found that group climate has a stronger effect on employee actions and behavior than does organizational climate. Conclusions also support earlier findings of a significant relationship between safety climate and safety decision choice by Keren et al. (2009). Given the daily interaction between supervisors and employees, it is not unexpected to find that perceptions of group trust, consistency, credibility and safety would impact the decision choice. However, the variance explained by group safety climate is still only about 5% for the trust variables of trust, consistency, and credibility and about 3% for group safety climate. That safety climate explains only a small amount of variance in decision choice is not a surprise, given that safety climate's unpredictable relationship with safety behavior has frustrated researchers for decades. While perceptions of trust and safety explain significant amount of variance in the regression model, identifying other factors which influence employee decisions concerning safety is a continuing challenge for safety researchers.

IMPLICATIONS FOR INDUSTRY

Workplace safety has many contributing factors. In a hazardous work environment, safe work practices are often the difference between going home at the end of the day and ending the day injured or even worse, killed. For better or worse, worker behavior is always precipitated by a decision-making process. A better understanding of the factors which affect the process of decision-making in safety decision tasks has potential benefits for managers, supervisors, and workers. The results of this study suggest an important relationship between

employee perceptions of trust and safety climate at two tiers. At the group tier, perceptions of trust, consistency, and credibility play a significant role in workers' choice to make a safe decision. Moreover, safety climate at both tiers significantly predicts a choice of a safer decision by employees. This work builds on previous work which proposes that worker perceptions play a role in safety climate (McLain & Jarrell, 2007; Zohar & Luria, 2005) and that trust plays a role in determining those perceptions (Kath et al.,2010). Additionally, data from this project strengthens the argument that workers who feel more positively about safety at both organizational and group tiers will make safer decision choices, which will lead to safer behavior (Keren et al., 2009; Zohar & Luria, 2005)

Although this research was the first of its kind in this work environment and used the relatively new measure of safety decision-making (Mills, 2007; Keren et al., 2009), several important implications emerged. First, organizational trust levels have a substantial impact on employee perceptions of safety climate for both the organizational and within work groups, confirming previous research which clearly links perceptions of safety with employee behaviors and attitudes (Johnson, 2007; Mullen, 2004; Vredenburgh, 2002; Zohar, 2002). Although the relationship between organizational safety climate and decision choice was not significant, group attitudes did demonstrate a significant prediction with safer decision-making choices, an expected finding. The daily interactions most employees have with their work groups would lead one to expect a larger impact than that which could be linked to a management team employees rarely see and interact with (Zohar & Luria, 2005). Finally, the findings of this study suggest that peer pressure may play an important role in the employee decision-making process in a positive as well as a negative way. Safety intervention targeting peer pressure from both a positive and negative perspective could be relevant to employees who struggle with peers who do not prioritize safety.

The findings of this study suggest that the role of management and supervisors in employee safety outcomes should not be discounted. However, perceptions of trust and safety may vary at different tiers of administration and perceptions at different tiers may influence employee actions differently. Low trust in management may have different effects than low trust levels in supervisors. The prevention of safety incidents has many factors. The perceptions of employees may be one of the more difficult factors to manage and control

because of the strong perceptual component (Das et al., 2008), but this research suggests that consistent and credible behavior by managers and supervisors could positively influence workplace safety outcomes.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORK

Several limitations concerning this research should be noted. First, a small sample size limits the ability to generalize these data to a larger population. In addition, the data collection process included many steps and was unfamiliar to participants, leading to possible measurement error. Both of these biases may have affected the final results of the study. Additionally, data were collected from one industry, using cross-sectional data collection techniques, in one region of the United States. A larger, more heterogeneous sample would strengthen the conclusions of this study substantially. Related to this, the research subjects were drawn from a group of organizations which volunteered for the study. This introduces potential for selection bias. Another limitation involves the decision scenario – the scenario tested was one situation framed from one angle (i.e. with a positive peer pressure dimension). Therefore, responses from employees may be different for other decision scenarios, limiting the applicability of results for other safety scenarios even within the same work environment. Finally, it is important to acknowledge that employee responses were hypothetical. While the employees stated that this was the decision choice they would make under these conditions, the difference between what employees say would do and what they might actually do is well documented by behavioral theory (Murphy, 2003). These are limitations and the researchers acknowledge the potential error they bring to the conclusions of the study.

This research was the first to examine safety decision-making in the grain handling environment. Conclusions have raised many questions that could be addressed with additional empirical evidence. To better understand the differences between perceptions at the organizational and group tiers, more cross-tier research should be completed. To better study the wide variety of safety scenarios faced by grain elevator employees, alternate decision scenarios should be developed and tested. Additionally, the emphasis of peer pressure in the decision process also warrants additional investigation and perhaps comparison of negative peer pressure versus positive peer pressure. Additional work

concerning the search dimensions of interest (i.e. safety, productivity, supervisor's opinion, and peer pressure) would also be of interest. Some of these have theoretical linkages to safety outcomes, especially that of productivity (McLain & Jarrell, 2007). Finally, a duplicate design with a wider population and more diversity in terms of gender, occupation, and workplace hazards would add to the existing body of knowledge.

Even with the limitations and additional questions noted, it is clear that organizational and group trust levels do impact the perceptions employees have for safety climate and that these perceptions influence the decision-making process at the organizational tier and decision choice at the group tier. Trust and safety climate perceptions are two of many factors influencing the decision-making of employees on the job. For managers and supervisors, understanding, acknowledging, and addressing these factors in a meaningful way is an essential part of managing occupational safety.

REFERENCES

Amendola, A. (2001). Recent paradigms for risk informed decision making. *Safety Science*, 40(1-4), 17-30.

Arboleda, A., Morrow, P., Crum, M.R., & Shelley, M.C. (2003). Management practices as antecedents of safety culture within the trucking industry: Similarities and differences by hierarchical level. *Journal of Safety Research*, 34(2), 189-197.

Brandon, H. (August 4, 2009). Grain storage – deadly dangers. *Delta Farm Press*. Downloaded   August 6, 2009 from: http://deltafarmpress.com/com/grain-storage-0804/

Brown, K.A., Willis, P.G. & Prussia, G.E. (2000). Predicting safety employee behavior in the steel industry: Development and test of a sociotechnical model. *Journal of Operations Management,* 18(4), 445-465.

Bureau of Labor Statistics. (2010). Census of fatal occupational injuries summary, 2009. Downloaded August 23, 2010 from: http://www.bls.gov/news.release/cfoi.nr0.htm.

Burns, C., Mearns, K. & McGeorge, P. (2006). Explicit and implicit trust within safety culture. *Risk Analysis*, 26(5), 1139-1150.

Cavazza, N. & Serpe, A. (2009). Effects of safety climate on safety norm violations: Exploring the mediating role of attitudinal ambivalence toward personal protective equipment. *Journal of Safety Research*, 40(4), 277-283.

Chapman, L.J. & Husberg, B. (2008). Agriculture, forestry, and fishing sector. *Journal of Safety Research*, 39(2), 171-173.

Choudhry, R.M. & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science,* 46(4), 566-584.

Clark, M.C. & Payne, R.L. (1997). The nature and structure of workers' trust in management. *Journal of Organizational Behavior*, 18, 205-224.

Clarke, S. (1999). Perceptions of organizational safety: Implications for the development of safety culture. *Journal of Organizational Behavior*, 20(2), 185-198.

Conchie, S.M. & Donald, I.J. (2008). The functions and development of safety-specific trust and distrust. *Safety Science*, 46(1), 92-103.

Cooper, M.D. & Phillips, R.A. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, 35(5), 497-512.

Cramer, D. (2003). *Advanced quantitative data analysis*. Philadelphia, PA: Open University Press, McGraw-Hill Education.

Cox, S. Jones, B. & Collinson, D. (2006). Trust relations in high-reliability organizations. *Risk Analysis*, 26(5), 1123-1138.

Das, A., Pagell, M., Behm, M., & Veltri, A. (2008). Toward a theory of the linkages between safety and quality. *Journal of Operations Management*, 26(4), 521-535.

Davis, J.H., Schoorman, F.D., Mayer, R.C., Tan, H.H. (2000). The trusted general manager and business unit performance: Empirical evidence of a competitive advantage. *Strategic Management Journal*, 21(5), 563-576.

Edmondson, A.C. (1996). Learning from mistakes is easier said than done: Group and organizational influences on the detection and correction of human error. *Journal of Applied Behavioral Science*, 32(1), 5-28.

Edwards. W. (1968). Conservatism in human information processing. In B. Kleinmuntz (Ed), *Formal representation of human judgment* (pp 17-52). New York: John Wiley & Sons.

Flin, R., Mearns, P., O'Connor, P. & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, 34(1-3), 177-192.

Fogarty, G.J. & Shaw, A. (2010). Safety climate and the Theory of Planned Behavior: Toward the prediction of unsafe behavior. *Accident Analysis and Prevention*, 42(5), 1455-1459.

Ford, J.K., Schmitt, N., Schechtman, S.L., Hults, B.M, & Doherty, M.L. (1989). Process tracing methods: contributions, problems, and neglected research questions. *Organizational Behavior and Human Decision Processes*, 43, 75-117.

Freeman, S.A., Kelley, K.W., Maier, D.E., & Field, W.E. (1998). Review of entrapments in bulk agricultural materials at commercial grain facilities. *Journal of Agricultural Safety and Health*, 4(2), 119-130.

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology*, 5, 347-358.

Heinrich, H.W. (1931). *Industrial accident prevention: A scientific approach*. New York: McGraw-Hill.

Henning, J.B., Stufft, C.J., Payne, S.C., Bergman, M.E., Mannan, M.S. & Keren, N. (2009). The influence of individual differences on organizational safety attitudes. *Safety Science*, 47, 337-345.

Hudson, P.T.W. (2009). Process indicators: Managing safety by the numbers. *Safety Science*, 47(4), 483-485.

Johnson, S.E. (2007). The predictive validity of safety climate. *Journal of Safety Research*, 38(5), 511-521.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decisions under risk. *Econometrica*, 47, 263-291.

Kath, L.M., Magley, V.J. & Marmet, M. (2010). The role of organizational trust in safety climate's influence on organizational outcomes. *Accident Analysis & Prevention*, 42(5), 1488-1497.

Keren, N., Freeman, S.A., & Schwab, C.V. (2006). Does SH&E education in high education institutes lead to a change in cognitive patterns among graduates?

Journal of SH&E Research, 3(2).

http://www.asse.org/academicsjournal/documents/06summer_keren.pdf

Keren, N., Mills, T.R., Freeman, S.A., & Shelley, M.C. (2009). Can level of safety climate predict level of orientation toward safety in a decision making task? *Safety Science*,47(10), 1312-1323.

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. *Journal of Agricultural Safety and Health*, 11(4), 395-405.

Lehtola, C.J., Brown, C.M. & Becker, W.J. (2008). Grain handling facilities – OSHA standard 1910.272. (ABE208). Gainesville, FL: Institute of Food and Agricultural Sciences, University of Florida. Downloaded June 16, 2008 from http://edis.ifas.ufl.edu/pdffiles/OA/OA11000.pdf.

Levin, S.L. (1999). Development of an instrument to measure organizational trust. Unpublished doctoral dissertation. The George Washington University: Washington, D.C.

Linstone, H.A. & Turoff, M. (2002). The Delphi method: Techniques and applications. Online textbook, ISBN 0-201-04294-0. Newark, NJ: New Jersey Institute of Technology. Downloaded August 4, 2008 from: http://is.njit.edu/pubs/delphibook/.

Maslow, A. (1970). *Motivation and personality* (2nd ed.). New York: Harper & Row.

Mayer, R.C. & Gavin, M.B. (2005). Trust in management & performance: Who minds the shop while the employees watch the boss? *Academy of Management Journal*, 48(5), 874-888.

McLain, D.L. & Jarrell, K.A. (2007). The perceived compatibility of safety and production expectations in hazardous occupations. *Journal of Safety Research*, 38(3), 299-309.

Mills, T.R. (2007). The effects of a safety climate on safety decision-making. Unpublished master's thesis. Iowa State University: Ames, IA.

Mintz, A. (2004). Foreign policy decision making in familiar and unfamiliar settings: An experimental study of high-ranking military officers. *Journal of Conflict Resolution*, 48(1), 91-104.

Mullen, J. (2004). Investigating factors that influence individual safety behavior at work. *Journal of Safety Research*, 35(13), 275-285.

Murphy, D.J. 2003. Human behavior theories, models, and applications. In D.J. Murphy (Ed), *Looking beneath the surface of agricultural safety and health*, (pp. 45-67). St. Joseph, Michigan: American Society of Agricultural Engineers.

National Safety Council. (2007). *Plain facts about the agricultural industry.* Downloaded February 11, 2010 from: http://www.nso.org/issues/agri.indus/htm.

Neal, A., Griffin, M.A., & Hart, P.M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, 34(1-3), 99-109.

Newell, B.R., Lagnado, D.A. & Shanks, D.R. (2007). *Straight choices: The psychology of decision making*. New York: Taylor & Francis Group.

Occupational Safety and Health Administration. (1988). *1910.272 – Grain handling facilities.* Standard number 1910.272. U.S. Department of Labor: Washington, D.C.

Occupational Safety and Health Administration. (2004). *Permit-required confined spaces*. Document 3138-01R. U.S. Department of Labor: Washington, D.C.

Payne, J.W., Bettman, J.R., & Johnson, E.M. (1993). *The adaptive decision-maker.* Cambridge: Cambridge University Press.

Peterson, D. (2000). The barriers to safety excellence. *Occupational Hazards*, 62(12).

Poortinga, W. & Pidgeon, N.F. (2004). Trust, the asymmetry principle, and the role of prior beliefs. *Risk Analysis*, 24(6), 1475-1486.

Prussia, G.E., Brown, K.A., & Willis, G.P. (2003). Mental models of safety: Do managers and employees see eye to eye? *Journal of Safety Research*, 33(2), 143-156.

Pousette, A., Larsson, S. & Torner, M. (2008). Safety climate cross-validation, strength and prediction of safety behavior. *Safety Science*, 46(3), 398-404.

Rains, G.C. (2004). Agricultural safety: Preventing injuries. Bulletin 1255. University of Georgia College of Agricultural & Environmental Sciences: Cooperative Extension Service.

Reason, J. (1997). *Managing the risks of organizational accidents*. Aldershot, UK: Ashgate.

Roberts, M. & Field, B. (2010). A disturbing trend: U.S. grain entrapments on the increase. *Resource: Engineering and Technology for a Sustainable World,* July/August 2010. 10-11.

Seo, D.C. (2005). An explicative model of unsafe work behavior. *Safety Science,* 43(3), 187-211.

Seo, D., Torabi, M.R., Blair, E.H., & Ellis, N.T. (2004). A cross-validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research*, 35(4), 427-445.

Simon, H.A. (1955). A behavioral model of rational choice. *Quarterly Journal of Economics*, 69, 99-118.

Simon, H.A. (1956). Rational choice and the structure of environments. *Psychological Review*, 63, 129-138.

Sharps, M.J. & Martin, S.S. (2002). "Mindless" decision making as a failure of contextual reasoning. *The Journal of Psychology*, 136(3), 272-282.

Thompson, R., Hilton, T., & Witt, A. (1998). Where the rubber meets the shop floor: A confirmatory model of management influence on workplace safety. *Journal of Safety Research*, 29(1), 15-24.

Tversky, A. & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 211, 453-458.

Tversky, A. & Wakker, P. (1995). Risk attitudes and decision weights. *Econometrica*, 63(6), 1255-1280.

United States Department of Labor (2008). *Workplace injuries & illnesses in 2007*. Bureau of labor statistics: Washington, D.C. Downloaded March 16, 2009 from: http://www.bls.gov/news.release/pdf/osh.pdf

Vredenburgh, A.G. (2002). Organizational safety: Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research*, 33(2), 259-276.

Walker, G.W. (2010). A safety counterculture challenge to a "safety climate". *Safety Science*, 48(3), 333-341.

White, M.P. & Eiser, J.R. (2006). Marginal trust in risk managers: Building & losing trust following decisions under uncertainty. *Risk Analysis,* 26(5), 1187-1203.

Whitener, E.M., Brodt, S.E., Korsgaard, M.A., & Werner, J.M. (1998). Managers as initiators of trust: An exchange relationship framework for understanding managerial trustworthy behavior. *Academy of Management Review*, 23(3), 513-530.

Williamson, A. M. , Feyer, A-M., Cairns, D., & Biancotti, D. (1997). The development of a measure of safety climate: The role of safety perceptions and attitudes. *Safety Science*, 25(1-3), 15-27.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical & applied implications. *Journal of Applied Psychology*, 65(1), 96-102.

Zohar, D. (2000). A group-level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology*, 85(4), 587-596.

Zohar, D. (2002). Modifying supervisory practices to improve subunit safety: A leadership-based intervention model. *Journal of Applied Psychology*, 87(1), 156-163.

Zohar, D. (2003). The use of supervisory practices as leverage to improve safety behavior: A cross-level intervention model. *Journal of Safety Research*, 34(5), 567-577.

Zohar, D. (2008). Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46(3), 376-387.

Zohar, D. & Erev, I. (2007). On the difficulty of promoting workers' safety behavior: Overcoming the underweighting of routine tasks. *International Journal of Risk Assessment & Management*, 7(2), 122-136.

Zohar, D. & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4) 616-628.

Chapter 4. Measurement and analysis of employee decision-making concerning the management of high moisture grain

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ABSTRACT

Quality management systems have been shown to improve inventory management, increase internal efficiencies, and enhance the ability of businesses to meet customer specifications but little work has explored the role of employees in the success of such systems. Several factors are thought to influence employee perceptions of quality climate and their quality-related decisions. One of these factors is employee trust in their management (organizational) and supervisory (group) personnel. This study develops the concept of quality climate in the grain handling environment and examines the relationship between perceptions of trust, quality climate, and employee decision-making. Employees from three commercial grain handling facilities completed questionnaires on perceptions of trust and quality climate and participated in a computerized quality decision-making simulation. Descriptive statistics, correlation, and hierarchal regression analysis were used to calculate the relationship between the variables. A positive significant relationship was noted between organizational trust and organizational quality climate. Organizational trust failed to significantly predict decision choice in a quality decision task, but group level consistency was a significant predictor of decision choice more orientated toward quality. Organizational quality climate significantly predicted decision choice, but not the decision-making process while group quality climate did not significantly predict decision choice but significantly predicted the decision-making process. Data from the project suggest that perceptions of trust and quality climate play a role in quality decision-making of employees. Data also show that employees do not perceive a connection between supervisors and quality climate. This research is the first in this area of study and several items need further exploration including the concept of quality climate in a grain handling environment and the measure of quality decision-making in the grain handling environment.

MOISTURE MANAGEMENT OF CORN

Prudent post-harvest management of commodity grains such as corn helps prevent spoilage, preserve quality attributes, and establish marketability (Bern and Brumm 2003; Hellevang 1995; Reed 2006). Bern, Quick, and Herum (2003) and Reed (2006) argue that of all quality attributes to be managed during storage, moisture is the most important. Moisture plays a critical role in the development of mold in corn and is also important in controlling insects and other foreign material in storage. Moisture levels must also be considered during aeration, fumigation, blending, and in the calculation of shrink (Hellevang 1995; Reed 2006). However, perhaps the most important effect of moisture on corn is economic. The moisture levels in corn directly influence the market price (Bern and Brumm 2003; Hellevang 1995).

Moisture levels determine storage and management strategies for corn. High moisture corn cannot be marketed through normal channels without extensive drying and may limit handling, storage, and feeding options (Bern et al. 2003). Although high moisture corn can be dried, drying wet corn to the conventional long term storage moisture level of approximately 14%-15% (Bern, Hurburgh, and Brumm 2008) uses more energy, takes more time, and reduces the capacity of grain handling systems (Roberts and Stroshine 2009). Storage time for higher moisture corn is also greatly reduced (Hurburgh and Elmore 2009).

In most growing years, corn moisture levels at harvest are between 18-22%. The 2008 and 2009 growing years were challenging for both producers and grain handlers (Hurburgh and Elmore 2009). Delayed planting, cool wet summers, and cold wet falls kept producers from harvesting corn and stressed the storage and drying capacities of many commercial grain elevators in the United States. Although it is typical for corn and other grains to be stored in outside piles temporarily while storage and rail car capacities catch up with the abundant harvest each fall (Bern et al. 2003), in 2008 and 2009, temporary storage turned into permanent storage for many grain elevators. Considering that the recommendation for storing grain in an outdoor pile is to start with dry corn, it was no surprise that by the spring of 2010, many grain elevators were dealing with unprecedented spoilage levels (Hurburgh 2010). Management practices that had always been adequate for handling damaged corn were no longer acceptable.

QUALITY MANAGEMENT SYSTEMS IN AGRICULTURE

Recent food safety issues involving commodity grain have added to the concern already building concerning the safety of food and feed. As food systems increase in complexity and consumer expectations for safe foods increase (Thakur and Hurburgh 2009), grain handling organizations are forced to reconsider and reformulate existing grain handling procedures (Voigt 2005).

The bulk commodity handling industry has not traditionally focused on food safety (Laux and Hurburgh 2010; Thakur and Hurburgh 2009), but recent food safety concerns have focused attention on this matter. Several food safety incidents have involved the adulteration of bulk agricultural commodity products (FDA 2010; Harris 2009; Lin et al. 2002; Martin and Moss 2009; Moss 2009). Without a standard methodology for implementing quality systems, the ability of processors, regulators, and consumers to identify, isolate, and contain unsafe products within the food and foodstuffs supply chain is limited (Harris 2009; Thakur and Hurburgh 2009).

In response to the needs of supply chain stakeholders, grain handlers have begun to recognize the potential of quality management systems (Laux and Hurburgh 2010). The practices of quality applied to the food production and processing have the potential solution to address food safety as well as other important components of handling and processing organizations, including inventory management, security, and legislative compliance (Laux 2007; Laux and Hurburgh 2010; Thakur et al. 2009). These systems have been used in manufacturing to improve efficiency and maintain high levels of quality (Bowersox, Closs, and Cooper 2007; Das, Pagell, Behm, and Veltri 2008; Deming 2000), but have had limited use in bulk commodity agricultural handling (Hurburgh and Lawrence 2003).

Traditionally, quality management systems have focused on improving a firm's strategic position and operating efficiency by focusing on customer needs and quality objectives (Foster 2008; Laux and Hurburgh 2010). The systems approach of these programs emphasize the interacting aspects of organizational components such as processes and procedures, machines and equipment, facilities, inputs, and personnel. The use of such systems in agriculture has been offered as one way to address several long-standing quality

issues in the United States commodity grain market (Lawrence and Hurburgh 2003; Thakur and Hurburgh 2009; Thakur et al. 2009).

Laux (2007) demonstrated benefits for grain handling organizations in the areas of enhanced inventory management, increased compliance, and a better ability to add value to existing product. However, refinement and definition of procedures and processes as well as hardware improvements are only one component of the quality management system. One of the most difficult elements of the quality management system to both manage and control are personnel actions (Azanza and Zamora-Luna 2005; Henson and Heasman 1998; Luning and Marcelis 2007). Team-oriented employees who can assess situations, follow procedures, and perform required tasks consistently are a valuable component of any quality management system (Das et al. 2008; Luning and Marcelis 2007). Related to this, Baskerville and Dulipovici (2006) suggest that employee knowledge should be managed as an organizational resource with the intended result being daily routines and processes that facilitate appropriate actions.

Employees, their perceptions, and the management of their accumulated knowledge which result from these perceptions have also been shown to be an important component of significant changes in the workplace (Chrusciel 2004; Chrusciel and Field 2003; Liebowitz 1999). In the grain handling industry, quality management systems which go beyond the conventional commodity-based grades can be defined as significant change (Hurburgh and Lawrence 2003; Laux and Hurburgh 2010).

Employee decisions constitute a major portion of appropriate action in both positive and negative ways. Consequently, the decision making patterns of employees have the potential to work for or against organizational quality management processes (Luning and Marcelis 2007). Quality processes in food and agriculture systems assume that employees are following procedures and behaving in predictable ways and if this does not occur, the success of such a system can be severely threatened (Luning and Marcelis 2007). Although quality management has the potential to uncover operational efficiencies, improve inventory management, and increase legal compliance, none of these improvements can be realized if employees do not make positive quality-oriented decisions on the job.

TRUST AND QUALITY

Several factors are believed to affect the employee's ability to make positive quality-related decisions. Two of these factors will be explored in this research. The first factor is the level of trust employees have for their management and supervisor. Little research has explored this relationship (Evans, Michael, Wiedenbeck, and Ray 2005). Quality management expert Deming (2000) placed much of the responsibility for quality on the management, viewing quality as a system controlled by management. Peterson (1998) and Saraph, Benson, and Schroeder (1989) suggest that trust and management commitment to quality is central to building a system that promotes quality processes continuously.

The second factor to be examined in this research is the concept of quality climate. This factor is based on the safety climate measurement, which measures the shared perceptions employees have of safety policies, procedures, and practices (Zohar 2008). Safety climate has been explored extensively in the safety literature, particularly with regard to its relationship to employee performance (Cooper and Phillips 2004; Johnson 2007; Zohar 2002). Quality climate and its impact on employee behavior has been largely ignored even though employee participation and training is considered a substantial predictor of improved organizational quality (Chrusciel 2004; Saraph et al. 1989).

Although little empirical evidence exists to link trust with quality climate and employee decision-making, the relationship can be partially explained by the theory of cognitive dissonance (Das et al. 2008). The theory was developed by Festinger (1957) and aims to explain the relationship among contradicting cognitions or "pieces of knowledge". Operationally, the theory posits that when people are confronted with conflicting cognitions (i.e. quality or speed), they will attempt to resolve these conflicts to reduce their uncomfortable state of the mind. According to Das et al. (2008), employees will address the conflicts in one of three ways: first, ignore their own judgment and follow advice of the supervisor or manager; second, ignore the opinion of management and the supervisor and follow their own judgment; and third, delay action and do nothing until they are forced to make a decision. Of course, the third option does not solve the problem; rather, it just postpones the inevitable decision path until a later time. Additionally, the theory does not acknowledge a fourth scenario – that of no conflict between an employee's cognitions.

This work examines the association between employee trust in his or her management and supervisor and the independent variables of quality climate, quality decision choice, and dimensions influencing the decision-making process. The primary interest of researchers in this work was the amount of variance accounted for by the independent variables after controlling for other independent variables. To this end, the following research questions were explored:

1. Does the level of organizational or group trust predict the organizational or group quality climate within a grain handling work environment?
2. Does the level of organizational or group trust predict the decision choice by employees in a quality decision task?
3. Does the level of organizational or group trust predict a quality orientation to the decision-making process of employees in a quality decision task?
4. Does the level of organizational or group quality climate predict the decision choice by employee in a quality decision task?
5. Does the level of organizational or group quality climate predict a quality orientation to the decision-making process of employees in a quality decision task?

METHODOLOGY AND MEASURES

Participants in the study were employees of three Midwestern grain handling facilities. Employees who would be subject to quality-related decisions in their daily jobs (i.e. those who worked in clerical and administration were excluded) were offered the opportunity to participate in the project. Of the 410 invitations, 197 responded. Of these 197, 177 provided usable data, for a response rate of 43 percent. Data was collected from March 2010 until May of 2010. In discussion of data and results, organizational level factors refer to trust and quality climate for the management and group level factors refer to the same climate for supervisors.

Climate data were collected using existing questionnaires. The trust instrument was developed and validated by Levin (1999) to measure behavioral trust. The 40 item questionnaire asked employees to rate the frequency of behavioral actions by their management and supervisors on a 5 point scale (1 = always or almost always; 3 =

occasionally; 5 = rarely or never). Examples of items used included "top management tells the same story to each person they speak to" and "my supervisor does what he or she says they will do". Levin (1999) used factor analysis to reduce the number of factors describing behavioral trust to two: consistency and credibility. Factor analysis performed on data gathered for this project yielded similar results; therefore, employee perceptions of trust, consistency, and credibility are included in the model as the dependent variable.

The quality instrument was adapted from Zohar and Luria's (2005) organizational and group level safety climate questionnaire and used 16 items for management and 15 items for supervisors. Employees were asked to rate their agreement with statements concerning their view of quality climate at their company. Examples of items used include "top management provide all means necessary to perform jobs in a high-quality manner" and "my supervisor is strict about quality at the end of the day when we want to go home". Factor analysis yielded one universal quality climate factor for management and one for supervisors, therefore, aggregated scores for employee perceptions of organizational and group quality climate are used in analysis. The one-factor climate structure has also been suggested by others using the scale to measure safety climate (Johnson 2007; Zohar and Luria 2005).

All data-gathering instruments were presented to employees in a web-based format. The decision simulations were offered on the Decision Mind™ platform and the trust and quality climate instruments were administered using Survey Monkey. Questionnaires were presented in random order and questionnaire items were also randomized. The decision simulation was presented after trust and quality questionnaires were completed. Employees were able to complete the steps of the process at different times as their schedule allowed. To connect data from instrument to instrument, employees were given a set of three identification numbers. No personal identifiers were linked with the identification numbers to eliminate the possibility of tracking participants' responses and to encourage candid responses.

The decision-making task investigated in this work was employee decisions concerning the management and storage of wet corn. The scenario asks employees to make choice – do they follow direct orders from management and dump the wet corn onto an unmanaged pile on the ground or do they take action to better preserve the quality of the

product? Although this action is fairly straightforward, it illustrates implications for a larger question that can potentially be applied to other industries – does the employee follow the instructions from the supervisor and management, even if these do not promote high quality processes, or do they make a decision to disregard the management and supervisor in favor of a more quality-oriented decision?

Decision-making data was collected using the process-tracing method of measuring decisions. Process tracing utilizes a linear model and measures the intervening steps between information acquisition and decision choice, considered a fundamental principle in decision-making research. Additionally, process tracing addresses a major weakness of using structural modeling approaches by studying the steps a person uses to make a decision choice rather than the outcome of the decision choice (Ford et al. 1989). Data collected can then be used to infer information on the decision-making process used by employees as they make a choice on handling the hypothetical scenario presented to them (Ford et al. 1989; Keren, Mills, Freeman, and Shelley 2009; Payne, Bettman, and Johnson 1993).

The software platform Decision Mind™, a computerized decision-making simulation, was used to enable the process-tracing methodology (Mintz 2004). The simulation employs decision process-tracing by recording several key attributes of the decision making process, including: 1) sequence of information gathered, 2) the number of items viewed 3) the amount of time needed to complete the decision-making task, and 4) the choice.

Decision choices were presented in a matrix format as shown in Table 1 with four dimensions that were hypothesized to play a role in making the decision choice. With each decision simulation, employees read the hypothetical situation and then were presented four decision choices. Each square of the matrix (V) represents the evaluation of a given choice (C) on a given dimension (D) and a weighted numerical score (contained within V).

Table 1. Decision Mind^{TM} Decision Simulation Matrix

	C_1	C_2	C_3	C_4
D_1	V_{11}	V_{21}	V_{31}	V_{41}
D_2	V_{12}	V_{22}	V_{32}	V_{42}
D_3	V_{13}	V_{23}	V_{33}	V_{43}
D_4	V_{14}	V_{24}	V_{34}	V_{44}

The scenario was developed and critiqued by a panel of experts in grain elevator operations using a modified Delphi method (Linstone and Turoff 2002). Weighted scores for matrix squares (the Vs) were assigned by the same panel of experts on a scale from -10 to +10. Scores less than zero denote a negative evaluation and scores greater than zero designate a positive evaluation on that particular dimension.

Using the information contained within the matrix squares, employees viewed the information and then selected a decision choice. Scenarios were pilot tested on a small group with a moderate knowledge of grain elevator operations. Slight modifications were made to improve the clarity of survey instruments and the decision scenarios as a result of the pilot tests. The text of the scenario presented to participants and the dimensions are shown below. The matrix with outcomes and weighted values is shown in the appendix.

> *Long term storage of wet corn has been a continuing problem at the grain cooperative where you work. The policy of the cooperative is that no member of the cooperative should be turned away from delivering corn – all loads are received and stored somewhere.*
> *A member of the cooperative pulls in with a load of very wet corn. You are directed to dump the load directly on a large uncovered pile of corn on the ground near the storage bins. You do not know the moisture levels of the corn in the pile.*
> *You must decide on the next step. The following four items are your options.*
> > *1. Dump the corn*
> > *2. Do not accept corn*
> > *3. Dry corn first*
> > *4. Check moisture levels in pile*
> *These four dimensions could impact your decision.*
> > *1. Storage risk*
> > *2. Customer service*
> > *3. Costs to company*
> > *4. Company policy*
> *When you are ready, follow the steps below in order to initiate and complete the simulation.*

To provide a way to quantitatively present the information gathering process completed by participants, Keren, Freeman, and Schwab (2006) introduced the search index metric. The measurement calculates the ratio between the number of times information squares of one dimension have been reviewed as compared with the other dimensions.

Index values which equal one indicate the dimension has equal importance to others in the decision process. Values less than or greater than one represent a dimension of less

importance as compared with others or greater importance in relation to others, respectively. In this study, four dimensions were used: storage risk, customer service, costs to company, and company policy. The orientation most affiliated with quality in this decision scenario is the storage risk index. Employees who viewed storage risk dimensions were assumed to be considering quality management as a primary source of information in their decision process. The search indices are shown below with the appropriate equation. They include: Storage Risk Search Index (SR_SI), Customer Service Search Index (CS_SI), Cost to Company Search Index (CC_SI), and Company Policy Search Index (CP_SI). Calculations are shown below.

$$Sr\_SI = \frac{N_{Storage}}{\frac{1}{n}\sum_{i=1, i \neq Storage}^{n} N_i} \tag{1}$$

Where $N_{storage}$ denotes the number of times storage risk squares were viewed and N_i denote the number of times squares other than storage were viewed.

$$Cs\_SI = \frac{N_{Customer}}{\frac{1}{n}\sum_{i=1, i \neq Customer}^{n} N_i} \tag{2}$$

Where $N_{customer}$ denotes the number of times customer service squares were viewed, and N_i, denote the number of times squares other than customer service were viewed.

$$CC\_SI = \frac{N_{Cost}}{\frac{1}{n}\sum_{i=1, i \neq Cost}^{n} N_i} \tag{3}$$

Where N_{cost} denotes the number of times cost to company squares were viewed, and N_i, denote the number of times squares other than cost to company were viewed.

$$CC\_SI = \frac{N_{Policy}}{\frac{1}{n}\sum_{i=1, i \neq Policy}^{n} N_i} \tag{4}$$

Where N_{policy} denotes the number of times company policy squares were viewed, and N_i, denote the number of times squares company policy were viewed.

Results were calculated using Statistical Package for the Social Sciences (SPSS 18.0). Demographic information on the sample and a correlation matrix of bivariate correlations for organization and group level variables are presented first. The distributions of decision choices and search indices are presented next. To determine which factors were significant predictors of the dependent variables, hierarchical regression analysis was used (Cramer 2003). The process of hierarchical regression is used to determine the variance explained by certain variables when other influencing factors are controlled. The order by which variables

are entered is controlled by the researcher. In this study, the variance in the dependent variables (trust, consistency, and credibility) due to quality climate, quality decision choice, and quality decision dimensions is of interest. A second model has quality climate as the dependent variable, with quality decision choice and the quality decision-making dimensions as independent variables. Both the trust models and the quality climate model were estimated at two levels: organizational (management) and group (supervisory).

RESULTS

The sample consisted of 142 males and 35 females for a total number of 177. The age of participants ranged from below 21 to over 61, with the most common response (nearly 58%) being 31-50 years of age. Most participants belonged to one of two groups: those with less than three years on the job, (38.2%) and those who had been with the organization more than 10 years (34%). Nearly all (98%) had completed high school, with the majority (62%) completing at least some college.

Bivariate two-tailed correlations were calculated to illustrate the relationship between organization level variables. A correlation matrix reporting all values is shown in Table 2. Values in parentheses represent scale reliabilities as calculated by Alpha's Cronbach where relevant.

Table 2. Organizational Descriptive Data and Bivariate Correlations[a]

Variable	1	2	3	4	5	6	7	8
Org. Trust	1(0.97)							
Org. Consistency	.842**	1						
Org. Credibility	.862**	.903**	1					
Org. Quality Climate	.655**	.618**	.634**	1(0.96)				
Quality Decision	-.167*	-.159*	-.160*	-.217**	1			
Storage Risk Index	-.030	-.009	-.019	.105	-.129	1		
Customer Service Index	.008	-.039	.031	-.106	-.013	-.168*	1	
Company Policy Index	.174*	.138	.187*	.106	-.034	-0.256**	-.288**	1
Cost to Company Index	-.043	-.011	-.069	-.118	-.061	-.360**	-0.170*	-.233**

[a]n = 177;**$p<0.01$; * $p< 0.05$

Group level variables were calculated in the same way as organizational variables. These data are shown in Table 3. Because of the strong inter-correlations between trust, consistency, and credibility (>0.700) and the similarity in the correlations with other variables (≤ 0.054 difference among correlation coefficients), only group trust is presented in Table 3.

Table 3. Group Bivariate Correlations[a]

Variable	1	2	3	4	5	6
Group Trust	1(0.97)					
Group Quality Climate	.130	1(0.97)				
Quality Decision	-.159*	-.003	1			
Storage Index	.032	.102	-.129	1		
Customer Service Index	-.032	-.030	-.013	-.168*	1	
Company Policy Index	0.122	.067	-.034	-.256**	-.288**	1
Cost to Company Index	-.084	.041	.061	-.360**	-.170**	-.233**

[a]n = 177; **$p < 0.01$; *$p< 0.05$

The second part of data collection was the decision-making scenario. Data derived from the quality decision simulation is classified in two ways: decision choice and decision-making process. The decision-making process is reflected by the search index values, which represent the information acquired by respondents in one dimension as compared with others. A value of 1 for a particular dimension indicates that no emphasis was given to that dimension above the others and therefore, represents the benchmark. A paired sample t-test was performed on each index to compare its value with 1. Values for the search indices and their respective paired sample t-tests are shown in Table 3.

Table 3. Information acquisition within a quality decision task[a]

Search Index	Mean	S.D.	t	P-value
Storage Risk	1.19	1.08	2.36	0.019
Customer Service	1.01	0.912	0.245	0.807
Company Policy	1.21	1.43	1.98	0.049
Cost to Company	0.927	0.631	-1.55	0.123

[a]n=177

Two search dimensions were significantly higher than the average. Storage risk and company policy were both given significantly more emphasis by decision-makers than dimensions in the areas of customer service and cost to company. The second piece of information contained within the decision-making simulation was the distribution of decision choice. These results are shown in Figure 2.

Figure 2. Distribution of frequency of decision choices in a quality decision task
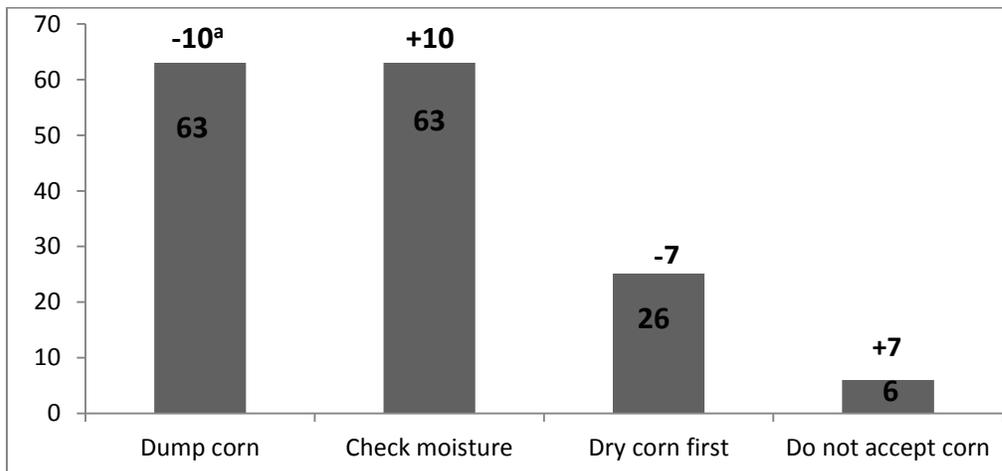
[a]Numbers on top of each bar represent utility scores in terms of quality

To measure how well the independent variables of quality climate, quality decision choice and the search dimensions explain the dependent variables, four regression models were estimated at each level. Three used the trust factors as the dependent variable (i.e. trust, consistency, and credibility) and one with quality climate as the dependent variable. Independent variables are added one at a time. The first model used organizational trust as the dependent variable, and the variables of interest were organizational quality climate, quality decision choice, storage index, customer service index, company policy index, and cost to company index. The second model defined perceptions of consistent behavior in management as the dependent variable and identical independent variables as for the first model. The third model included the same independent variables, but used employee perceptions of credibility in management as the dependent variable. The dependent variable used in the final model was organizational quality climate with decision choice, storage index, customer service index, company policy index, and cost to company index entered as the independent variables of interest.

Linear regression was used on all models to determine which variables could explain a significant amount of variance in the dependent variable. To calculate the proportion of variance explained by the independent variables of the model, the coefficient of determination (r^2) was calculated. The F test was used to determine if a statistically significant proportion of variance could be explained as each independent variable was entered into the model. Positive relationships represent more positive perceptions predict a higher perception or orientation toward the variable in question. Quality decision choices were reverse coded, with positive decisions having higher values, so negative relationships between decision choice and the trust and climate variables are desirable. The summary of the models are shown in Table 4.

Table 4. Summary of Organizational Hierarchical Regression Models[a, c]

Independent variables	Model 1 Organizational trust[b]	Model 2 Organizational consistency[b]	Model 3 Organizational credibility[b]	Model 4 Organizational quality climate[b]
Organizational quality climate	0.673**	0.649**	0.646**	-----
Quality decision choice	-0.031	-0.025	-0.023	-0.201*
Storage index	-0.011	-0.010	-0.006	0.028
Customer service index	0.202**	0.138	0.232**	-0.108
Company policy index	0.198**	0.148	0.223**	0.085
Cost to company index	0.133	0.144	0.120	-0.103
r^2	0.498	0.443	0.474	0.084
Adjusted r^2	0.477	0.411	0.446	0.052
F	23.80**	19.13**	21.62**	2.64*

[a]values represent standardized regression coefficients; [b]dependent variable;[c]n=177

**= $p<0.01$; *=$p<0.05$

Group models were created in the same way as those at the organizational level, with group trust, consistency, and credibility as the dependent variables and group quality climate, quality decision choice, and the search indices as independent variables in the first three models. The final model used group quality climate as the dependent variable and decision choice and the search indices as independent variables. As with the organizational models, the coefficient of determination (r^2) and the F-test were used to test whether the incremental variance explained by each variable added to the model was statistically significant. Group models are summarized in Table 5.

Table 5. Summary of Group Hierarchical Regression Models[a,c]

Independent variables	Model 1 Group Trust[b]	Model 2 Group consistency[b]	Model 3 Group credibility[b]	Model 4 Group quality climate[b]
Group quality climate	0.111	0.118	0.104	-----
Quality decision choice	-0.157	-0.166*	-0.133	0.016
Storage index	0.007	0.032	0.015	0.210*
Customer service index	-0.017	-0.010	-0.005	0.118
Company policy index	0.091	0.124	0.094	0.220*
Cost to company index	-0.077	-0.070	-0.101	0.215*
r^2	0.060	0.075	0.058	0.047
Adjusted r^2	0.021	0.037	0.019	0.015
F	1.54	1.95	1.48	1.45

[a]values represent standardized regression coefficients; [b]dependent variable;[c]n=177

**= $p < 0.01$; *=$p < 0.05$

DISCUSSION

Several significant findings emerged from this study. Each research question in the study will be reviewed along with the data findings which best answer the question posed. The first research question asked whether levels of organizational and group trust (trust in this case includes concepts of trust, consistency, and credibility) can predict organizational and group quality climate. In addition to the expected correlations between organizational trust variables (i.e. trust, consistency, and credibility), organizational variables for quality show several significant results. The major conclusions are listed below:

- The significant positive correlation found between organizational trust and organizational quality climate is notable in its strength, with quality climate responses explaining over 45 percent of the variance in trust responses
- Organizational consistency and credibility also were found to have a strongly significant positive correlation with organizational quality climate, where quality

climate explained approximately 42 percent and 41 percent of the variance in consistency and credibility, respectively

In all trust variables, a higher degree of organizational trust, consistency, and credibility significantly predicted a more positive organizational quality climate. This observation aligns with Deming's (2000) view that quality systems are controlled and administered by management. The influence of organizational quality climate on the trust variables was responsible for the high F values and the highly significant predictions on the first three organizational regression models. The same results were not noted at the group level. Group results are summarized below:

- Group trust, consistency, and credibility did not significantly predict group quality climate, explaining approximately 1 percent of the variance in group trust variables
- Group trust variables - trust, consistency, and credibility - did not explain a significant increment of variance in the regression model

Unlike the finding at the organizational level, more positive perceptions of group trust, consistency, and credibility were not found to significantly predict a more positive group quality climate. This finding was unexpected, contradicting the previous work on safety and other organizational climates (Evans et al., 2005; Patterson et al., 2005; Zohar, 2008). Although these data suggest an interpretation that quality climate is influenced by different factors than safety climate, it may also be that in the grain handling environment, employees do not link their supervisors or their work group with a climate of quality. Instead, they associate quality climate and quality processes with management, following the line of thought offered by Deming (2000).

The second research question asked whether organizational and group trust predicted the decision choice of employees. Figure 2, which illustrates the distribution of decision choices and Tables 4 and 5, provide the data needed to answer the research question. Results are shown below:

- Organizational trust variables – trust, consistency, and credibility – did not significantly predict the decision choice of employees

- One group trust variable – consistency – had a weak (p-value = .045) negative significant relationship with employee decision choice
- Generally, employees did not choose the quality-oriented alternatives. Instead, most chose to either follow orders or to pass the actual decision on to someone else

At both organizational and group tiers, higher levels of trust and credibility did not significantly predict the choice of a more quality-oriented decision. Higher group perceptions of consistency predicted a higher likelihood of making a decision which encouraged quality, but the relationship was weak. No relationship between consistency and decision choice was noted at the organizational tier.

In the decision scenario, the most quality-oriented choice was to not accept the corn. However, very few respondents chose this alternative. Rather, many chose to follow orders by dumping the corn. Because dumping corn on an unmanaged pile is fairly typical practice (Bern et al., 2003), it was not a surprise that many employees chose this option. While dumping the corn was not unexpected decision alternative, a surprising number chose to choose an option which was in effect a "non-choice". The decision alternatives of checking the moisture in the dump pile and drying the corn first are considered "non-choices" because they do not require an employee to make a decision about what to do with the wet corn. Instead, these decision choices allow the employees to pass the decision onto someone else by sending the customer elsewhere to resolve the problem of unloading the wet corn. Neither the decision choice to dump corn or the "non-choices" of checking the moisture or drying the corn first are decisions classified as positive from a quality management perspective. This phenomenon is known as the "free ride" in the decision-making literature. Free ride is when employees fail to correct an obvious safety issue because they figure someone else will take care of it. The tendency of workers to behave in the "free ride" manner was noted with respect to safety by Zohar and Erev (2007), and is worthy of further investigation in the quality domain.

Another unexpected finding was the weak relationship between group consistency and decision choice. It was surprising for two reasons. First, supervisors have much more interaction with employees, yet the relationship observed between group trust variables and

the decision choice of employees explains a very small increment of variance in the model, suggesting that employees perceive a small role for supervisors in quality improvement within the work environment. Furthermore, employees perceive quality as a management issue and not an issue they need to address. Second, the role of consistency in employees' decision choices seems to suggest that in terms of quality, employees value unchanging work expectations (i.e. consistency) over believability (i.e. trust or credibility) from their supervisors. Implications for the grain elevator based on these data are not positive in terms of quality. To realize success with quality management systems in the grain handling environment a stronger role must be created for supervisors in the development and implementation of quality programs as well as educational intervention to increase the willingness of employees to be more outspoken in their support of actions which could improve quality.

The third research question concerned whether organizational and group level trust predicted a quality orientation in the decision-making process. Major findings are listed below:

- No significant relationship was noted between organizational trust and the search index storage risk

- Organizational trust and credibility have a significant positive relationship with company policy and customer service

- Group trust variables have no significant relationship with search indices

In this case, a higher degree of organizational trust, consistency, and credibility does not significantly predict a stronger emphasis on storage risk during the decision-making process. However, more positive perceptions of organizational trust and credibility were found to significantly predict a higher orientation toward company policy and customer service. One reason for this could be that employees who have higher organizational trust and credibility levels may feel more responsibility to follow company policy and toward strong customer service. A stronger emphasis on company policy and customer service might also partially explain the large number of final decision choices to dump the corn. Dumping the customer's corn without delay is clearly advantageous to the customer and directly follows the policy specified by the management and the supervisor.

The significant correlations between search index dimensions in the organizational and group bivariate correlation tables are expected, as they are dependent on the other dimensions when measured with the search index metric. Therefore, when one dimension is selected more often another will be selected less often, leading to the negative correlations.

When the mean values of search indices were calculated (see Table 3) to determine which index was given the strongest emphasis in the decision-making process, company policy had the highest mean, followed closely by storage risk. Customer service was very close to the mean of one, indicating its role in the decision process was no more or no less important as compared with other indices. The only index below one was the cost to company. This was not an unexpected finding, considering many employees' general indifference to their company's financial bottom line.

The storage risk dimension represents a higher emphasis toward quality in this decision scenario; therefore, the higher mean value suggests that employees are thinking about quality while making their decision choice. However, the mean for company policy is also significantly greater than one, providing evidence that employees are also thinking about the expectations of their managers and supervisors. The cognitive conflict between the two pieces of knowledge playing out in the employee's mind during this decision-making process is well illustrated by the search indices.

The final two research questions concerned the role of the organizational and group tier quality climate in final decision choice and in an increased emphasis on quality in a quality decision-making task. The findings for both research questions are listed below:

- Organizational quality climate significantly predicts the choice of a decision promoting quality, but does not predict an increased emphasis on any of the search indices

- Group quality climate does not significantly predict the choice of a more positive quality decision, but did predict a higher orientation toward storage risk, company policy, and cost to company

A more positive view of organizational quality climate was found to significantly predict a positive quality decision choice. Although the relationship was not particularly strong (explaining less than 5 percent of the variance in the model), it was strong enough to

provide significant incremental value to the model, even given the lack of a significant relationship with the search index variables. This finding is unexpected from a theoretical basis. Management and organizational climate have been shown to play less of a role in employee actions in some cases than group climate, although they have been found to play a mediating role in other cases (Thompson et al, 1998; Zohar, 2008). However, once again, the finding aligns with hypotheses forwarded by Deming (2000) and others (Evans et al. 2005; Peterson 1998; Saraph et al. 1989) which assign the largest role of developing and creating quality processes within an organization to management.

Different conclusions were observed with group quality climate. Although more positive perceptions of group quality climate did not significantly predict a more positive quality decision choice, group quality climate did predict a higher emphasis toward the indices of storage risk, company policy, and cost to company. These results were unexpected in two ways. First, the lack of a significant relationship between group climate and decision choices refutes previous research that has suggested the supervisor plays a larger role in employee actions than management does within the organizational tier (Zohar 2008; Zohar and Luria 2005; Thompson et al. 1998).

Second, the search indices identified as significant components of the model would seem to provide conflicting information to the decision-maker. Therefore, the observation that storage risk, company policy, and cost to company were given emphasis by decision makers who also provided more positive assessments of group climate suggests the conflict inherent to this decision choice. Moreover, the significant negative correlations between the three search indices (indicating higher values of one predict lower values of the other(s)) further illustrate the conflict of this decision choice. Further study of these decision indices, along with additional research on the role of group quality climate on decision-making, would help to answer several unresolved questions.

LIMITATIONS & FUTURE RESEARCH

Several limitations to the study are acknowledged. The small sample size was cross-sectional and from a limited number of grain handling organizations, limiting the generalization of the findings to other industries and other organizations within the grain handling industry. In addition, the data collection procedures were relatively new to the

participants, introducing potential measurement error. Respondents volunteered for the study, so the possibility of a selection bias cannot be discounted. Furthermore, quality climate is a new and undefined construct. Although the quality climate questionnaire was found to be both reliable and valid, a questionnaire more specific to the agricultural environment might measure the construct of quality climate differently. Finally, although the decision search indices were developed and critiqued by experts in grain elevator management, there may be other indices that could better characterize the thought process of quality decision-making.

This was the first attempt at a study of this kind. The investigation raised several questions which could be addressed by future research. High priority needs for future research include:

- Further refinement and development of the quality climate measure and the quality decision scenario

- Development and testing of a second quality decision scenario for a grain handling environment

- Creation and testing of a quality climate measure suited specifically for the grain handling environment

- Strong linkages observed between the trust variables and organizational quality climate warrant further examination

- The lack of the connection between group trust variables and group quality climate must be addressed to implement quality management systems in a grain elevator environment

Workplace quality outcomes depend heavily on the decisions made by employees. Within the grain elevators surveyed, quality considerations play a reduced role in the decision process when compared with customer service and company policy. A quality program cannot be successful if employees are not making positive quality-oriented decisions. Additionally, a better understanding of the factors which influence the decision choices and decision-making process of employees plays an important role in workplace quality initiatives and may provide guidance on employee training needs. As the importance of quality management increases in the commodity grain handling industry, continued research on quality decision-making processes of employees is essential. Increased

knowledge of employee decision-making patterns will improve not only existing quality management programs, but increase the likelihood of successful implementation of new quality management systems within the grain handling environment.

REFERENCES

Azanza, M., Zamora-Luna, M.B.V. 2005. Barriers of HACCP team members to guideline adherence. *Food Control*, 16(1), 15-22.

Baskerville, R. and Dulipovici, A. 2006. The theoretical foundations of knowledge management. *Knowledge Management Research and Practice*, 4(1), 83-105.

Bern, C.J. and Brumm, T.J. 2003. Moisture content measurement. In *Encyclopedia of Agricultural, Food, and Biological Engineering*, D.R. Heldman, Ed. New York: NY: Marcel Dekker, Inc.

Bern, C.J., Quick, G., and Herum, F.L. 2003. Harvesting and postharvest management. In *Corn: Chemistry and technology*, P.J. White and L.A. Johnson, Eds. St Paul, MN: American Association of Cereal Chemists, Inc.

Bowersox, D., Closs, D., and Cooper, M.B. 2007. *Supply chain logistics management*. New York, NY: McGraw Hill.

Chrusciel, D. 2004. Considerations for dealing with significant organizational change. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International A65/08.

Chrusciel, D. and Field, D. 2003. From critical success factors into criteria for performance excellence – An organizational change strategy. *Journal of Industrial Technology*, 19(4).

Cooper, M.D. and Phillips, R.A. 2004. Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, 35(5), 497-512.

Cramer, D. 2003. *Advanced quantitative data analysis.* Philadelphia, PA: Open University Press, McGraw-Hill Education.

Das, A., Pagell, M., Behm, M, and Veltri, A. 2008. Toward a theory of the linkages between safety and quality. *Journal of Operations Management*, 26(4), 521-535.

Deming, W.E. 2000. *Out of the crisis*. Cambridge, MA: The MIT Press.

Evans, D.D., Michael, J.H., Wiedenbeck, J.K., and Ray, C.D. 2005. Relationships between organizational climates and safety-related events at four wood manufacturers. *Forest Products Journal*, 55(6), 23-29.

Food and Drug Administration. 2010. Recalls, Market Withdrawals, and Safety Alerts. FDA: United States Health and Human Services: Washington, D.C. Accessed on August 24, 2010 from http://www.fda.gov/Safety/Recalls/default.htm

Festinger, L. 1957. *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Ford, J.K., Schmitt, N., Schechtman, S.L., Hults, B.M, and Doherty, M.L. 1989. Process tracing methods: contributions, problems, and neglected research questions. *Organizational Behavior and Human Decision Processes*, 43, 75-117.

Foster, S.T. 2008. Towards an understanding of supply chain quality management. *Journal of Operations Management*, 26(4), 461-467.

Harris, G. 2009, March 26. Investigators find source of many foods untraceable. *New York Times*. Accessed on October 13, 2009 from http://www.nytimes.com/2009/03/26/health/policy/26fda.html

Hellevang, K.J. 1995. Grain moisture content effects and management. Document AE-905. Fargo, ND: North Dakota State University Extension Service. Downloaded April 21, 2009 from: http://www.ag.ndsu.nodak.edu/abeng/pdffiles/ae905.pdf

Henson, S. and Heasman, M. 1998. Food safety regulation and the firm: Understanding the compliance process. *Food Policy*,23(1), 9-23.

Hurburgh, C.R. 2010. Still the 2009 Crop and Now 2010 Corn and Soybeans. Presentation given to the GEAPS Greater Iowa Chapter, September 14, 2010. Downloaded on November 17, 2010 from: http://www.extension.iastate.edu/grain/.

Hurburgh, C.R., Bern, C.J. and Brumm, T.J. 2008. Grain moisture and weight. In *Managing grain after harvest*, an internal textbook used in the Department of Agricultural and Biosystems Engineering, Iowa State University.

Hurburgh, C. and Elmore, R. 2009. 2009 Corn quality issues – storage management. Integrated Crop Management News, October 15, 2009. Ames, IA: Iowa State

University Extension. Downloaded September 28, 2010 from:
http://www.extension.iastate.edu/CropNews/2009/1015hurburghelmore02.htm

Hurburgh, C.R. and Lawrence, J.D. 2003. The need for QMS. *Resource: Engineering and Technology for a Sustainable World,* 10(9), September 2003, 29.

Johnson, S.E. 2007. The predictive validity of safety climate. *Journal of Safety Research*, 38(5), 511-521.

Keren, N., Freeman, S.A., and Schwab, C.V. 2006. Does SH and E education in high education institutes lead to a change in cognitive patterns among graduates? *Journal of SH and E Research*, 3(2). http://www.asse.org/academicsjournal/documents/06summer_keren.pdf

Keren, N., Mills, T.R., Freeman, S.A., and Shelley, M.C. 2009. Can level of safety climate predict level of orientation toward safety in a decision making task? *Safety Science*, 47(10), 1312-1323.

Laux, C.M. 2007. The impacts of a formal quality management system: A case study of implementing ISO 9000 at Farmer's Cooperative Company, Iowa. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International B68/07.

Laux, C.M. and Hurburgh, C.R. 2010. Using quality management systems for food traceability. *Journal of Industrial Technology*, 26(3).

Levin, S.L. 1999. Development of an instrument to measure organizational trust. Unpublished doctoral dissertation, The George Washington University. Dissertation Abstracts International A60/02

Liebowitz, J. 1999. Key ingredients to the success of an organization's knowledge management strategy. *Knowledge and Process Management*, 6(1), 37-40.

Lin, W. Price, G.K. and Allen, E. 2002. Starlink: Impacts on the U.S. corn market and world trade. In *USDA Feed Yearbook/FDS-2001*. United States Department of Agriculture: Washington, D.C.

Linstone, H.A. and Turoff, M. 2002. *The Delphi method: Techniques and applications*. Online textbook, ISBN 0-201-04294-0. Newark, NJ: New Jersey Institute of Technology. Downloaded August 4, 2008 from: http://is.njit.edu/pubs/delphibook/.

Lunning, P.A. and Marcelis, W.J. 2007. A conceptual model of food quality management functions based on a techno-managerial approach. *Trends in Food Science and Technology*, 18, 159-166.

Martin, A. and Moss, M. 2009, March 30. Salmonella in Pistachios Spurs Recall. *The New York Times*. Accessed on August 18, 2010 from http://www.nytimes.com/2009/03/31/business/31nuts.html.

Mintz, A. 2004. Foreign policy decision making in familiar and unfamiliar settings: An experimental study of high-ranking military officers. *Journal of Conflict Resolution*, 48(1), 91-104.

Moss, M. 2009, February 9. Peanut case shows holes in safety net. *The New York Times.* Accessed on October 13, 2009 from: http://www.nytimes.com/2009/02/09/us/09peanuts.html

Patterson, M.G., West, M.A., Shackleton, V.J., Dawson, J.F., Lawthom, R., Maitlis, S., Robinson, D.L., and Wallace, A.M. 2005. Validating the organizational climate measure: Links to managerial practices, productivity, and innovation. *Journal of Organizational Behavior*, 26(4), 379-408.

Payne, J.W., Bettman, J.R., and Johnson, E.M. 1993. *The adaptive decision-maker.* Cambridge: Cambridge University Press.

Peterson, R. 1998. Trust for quality. *The TQM Magazine*, 10(6), 413-416.

Reed, C.R. 2006. *Managing stored grain to preserve quality and value.* St. Paul, Minnesota: American Association of Cereal Chemistry International.

Roberts, M. and Stroshine, R. 2009. Managing the 2009 harvest: Resources for drying, storing, grain quality, crop insurance and marketing. West Lafayette, IN: Purdue University Extension. Downloaded September 20, 2010 from: http://extension.purdue.edu/grainlab/content/pdf/2009_harvest_10_30_09.pdf.

Saraph, J.V., Benson, P.G., and Schroeder, R.G. 1989. An instrument for measuring the critical factors of quality management. *Decision Sciences*, 20(4), 810-829.

Thakur, M. and Hurburgh, C.R. 2009. Framework for implementing traceability system in the bulk grain supply chain. *Journal of Food Engineering*, 95(4), 617-626.

Thakur, M. Mosher, G.A., Brown, B., Bennet, G.S., Shepherd, H.E., and Hurburgh, C.R. 2009. Traceability in the bulk grain supply chain. *Resource: Engineering and Technology for a Sustainable World*, April/May, 20-22.

Thompson, R., Hilton, T., and Witt, A. 1998. Where the rubber meets the shop floor: A confirmatory model of management influence on workplace safety. *Journal of Safety Research*, 29(1), 15-24.

Voigt, J. 2005. Maintaining quality and purity in commercial elevators and equipment. Proceedings of the Grain Elevator and Processing Society (GEAPS). Downloaded on February 23, 2009 from http://www.geaps.com/proceedings/2005/voigt.cfm.

Zohar, D. 2002. Modifying supervisory practices to improve subunit safety: A leadership-based   intervention model. *Journal of Applied Psychology*, 87(1), 156-163.

Zohar, D. 2008. Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46(3), 376-387.

Zohar, D. and Luria, G. 2005. A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4) 616-628.

Zohar, D. & Erev, I. (2007). On the difficulty of promoting workers' safety behavior: Overcoming the underweighting of routine tasks. *International journal of risk assessment & management*, 7(2), 122-136.

Chapter 5. The management of safety and quality and the relationship with worker decisions in the country grain elevator

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ABSTRACT

Human factors play an important role in the management of safety and quality in the work environment. Although employee actions and decisions have been identified as a key component of successful occupational safety programs and quality management programs, little attention has been given to the employees' role in these types of programs. This research explored two relationships which have theoretical connections, but little previous research: the relationship between safety and quality climate and the relationship between climates at the organizational and group level. Survey data were collected at three bulk commodity grain elevators from 178 employees. Employees also participated in safety and quality decision-making simulations. Significant predictions were noted for safety and quality climate. Decision-making predictions are also discussed. This research suggests that organizational safety is an important predictor of group safety. In addition, recognizing the larger role supervisors play in group workplace behavior, more should be done to increase employee perceptions of group level involvement in quality climate to promote more quality-oriented decision-making by employees.

INTRODUCTION TO RESEARCH

Human factors play an important, but often overlooked, role in the management of safety and quality in the work environment. Both occupational safety and quality management programs depend on team-oriented employees who can assess situations, follow procedures, and perform required tasks consistently (Das et al. 2008; Luning and Marcelis 2007). Employee perceptions are hypothesized to play a substantial role in employee behavior. Furthermore, employee decisions are an important precursor to behavior (Newell, Lagnado, and Shanks 2007). Theoretical perspectives addressing both motivation and

employee decision-making processes suggest that employee perceptions in safety are related to their perceptions of quality and together, may influence the quality related decision-making process of an employee (Das et al. 2008; Deming 2000; Evans et al. 2005; Maslow 1970; Murphy 2003).

Another strong influence on employee decisions is the environment in which decision choices are made (Patterson et al. 2005; Simard and Marchand 1995; Thompson et al. 1998; Zohar 2008). Both managers and supervisors affect employee actions in a workplace environment, but they do so in different ways. Previous research has examined the relationship between perceptions of organizational climate, that which is related to the employee's relationship with the management team, and perceptions of group climate, the underlying expectations and understandings concerning the employee's relationship with his or her supervisor (Hofmann et al. 1995; Thompson et al. 1998; Zohar 2008).

This research will explore two relationships which have received relatively little attention in previous research. The first objective is to explore the relationship between perceptions of safety and perceptions of quality of workers in the commercial grain elevator work environment and how these perceptions affect the decision choices of employees in safety and quality-related decision tasks. The second objective of the research is to explore the relationship between perceptions at the organizational level and perceptions at the group level. Both safety and quality have well known benefits for organizations. Safe workplaces benefit both workers and the organization (Goetsch 2008). Quality management systems have the potential to increase revenue, improve inventory management, and improve the performance of organizations (Naveh and Marcus 2007; Psomas et al. 2010; Rao et al. 1997). Employees and the decisions they make play major roles in the success of both types of programs (Cooper and Phillips 2004; Howard and Foster 1999; Neal et al. 2000). Additional knowledge of factors impacting employee decisions are helpful to researchers and managers in the development of more responsive educational intervention as well as provide guidance for spending limited employee training dollars.

SAFETY AND QUALITY IN THE GRAIN HANDLING INDUSTRY

The setting of this research is a commercial grain handling facility. Safety has historically played an important role in operations management at such facilities, but the

measurement of quality indicators and quality performance is a more recent facet of interest (Capmany et al. 2000; Hurburgh and Lawrence 2003). Work environments within the commercial agricultural handling industry have no shortage of safety hazards and production agriculture has long been considered a hazardous profession based on the number of safety incidents recorded annually (Chapman and Husberg 2008; National Safety Council 2007; U.S. Department of Labor 2008).

On any given day, management and supervisors at grain handling facilities may deal with a wide variety of safety hazards including confined spaces, petroleum and electrical dangers, and lock out/tag out procedures. Other challenges of these types of facilities include extreme pressure for high productivity in the planting and harvest seasons and large numbers of temporary and seasonal employees (Chapman and Husberg 2008; Lehtola et al. 2008; Roberts and Field 2010). Although employees are well aware of the hazards they face (Walker 2010), incidents still occur and fatality and injury rates for the agricultural industry are nearly always higher than those in other industries (Bureau of Labor Statistics 2010).

Quality beyond generic commodity grades has not typically been a primary operational consideration for grain handling organizations (Thakur and Hurburgh 2009), but this situation is rapidly changing. Production agriculture is becoming more focused on product isolation, source verification, traceability and other differentiation processes to add value to bulk commodity crops (Miranowski et al. 2004), but even without specialized markets, the quality of grain is a key consideration in its storability, marketability, and end uses (Reed 2006). Judicious post-harvest management of commodity grains helps prevent spoilage, preserve quality attributes, and establish marketability (Bern and Brumm 2003; Hellevang 1995; Reed 2006). Grain quality researchers (Bern et al. 2003; Reed 2006) assert that of all attributes to be managed during grain storage, moisture is the most important. Moisture plays a critical role in the development of mold in granular grains such as corn and wheat and is also an important component of controlling insects and other foreign material in storage.

The lack of quality controls and quality management procedures for bulk commodity grains has received greater attention recently. Several food safety incidents have involved the adulteration of bulk agricultural commodity products (FDA 2010; Harris 2009; Martin and

Moss 2009; Moss 2009). Without a standard methodology for implementing quality systems, the ability of processors, regulators, and consumers to identify, isolate, and contain unsafe products within the food and foodstuffs supply chain is limited (Harris, 2009; Thakur and Hurburgh, 2009). In both existing and emerging agricultural markets, management of and increased efficiencies in bulk grain handling can be facilitated through a quality management system (Laux 2007; Laux and Hurburgh 2010; Thakur et al. 2009).

Research by Laux (2007) and Thakur (2010) detailed the operationalization of quality management systems in a grain handling organization. Both identified several benefits, including tighter management of inventory, improvement of grading functions, optimization of blending procedures, better legislative compliance, and the addition of value to low quality grain products. While the research illustrated several key benefits of tighter management of grain quality factors in a grain elevator environment, one area which remains unexamined by researchers is how employee actions impact a quality management system in a grain handling environment. These employee actions are especially important in situations where the employee decision determines how the quality process will be interpreted and carried out. For example, management procedures for an out-of-condition grain product such as high moisture corn could be identified as part of a quality management system, providing guidance to employees. However, if the employees, supervisors, or management choose not to follow the guidelines provided by quality management systems, how will this action affect the success of the system?

THEORETICAL CONNECTIONS BETWEEN SAFETY AND QUALITY

Out-of-condition grain has been identified as a safety hazard by several researchers. In the review of grain engulfments at commercial grain elevators by Freeman et al. (1998), out-of-condition grain played a significant role in 81% of incidents. Kingman and Field (2005) identified moldy grain as an important contributor toward farm-level grain engulfments and suffocations. In their summary of 2009 grain engulfments in the United States, Roberts and Field (2010) noted a positive relationship between out-of-condition grain and the probability of engulfment. All of these data summaries are based on a database of

U.S. grain engulfments recorded by Purdue University and include all recorded incidents since 1978.

The link between out-of-condition grain and employee safety is only one theoretical connection between safety and quality. Quality researchers have noted that many processes developed for quality management programs can be applied toward improvements in safety, including process documentation, root cause analysis, and data-based decision-making (Brown 1996). The role management plays in safety (Conchie and Burns 2008; Flin et al. 2000) and quality systems is well documented.

Indeed, quality expert Deming (2000) assigns managers the largest role in developing and overseeing quality, viewing quality as a system which management controls. Salazar (1989) examines Deming's philosophy in greater detail from a safety perspective, viewing safety as a system which can be improved continuously. Salazar (1989) also notes that, with both systems, the goal is less about counting the number of defects or injuries, but to understand the system which allowed the injury to occur. Dekker (2002) adds to this thought by pointing out that using hindsight to judge the injury is subject to bias and works against the process of learning from the mistake. Deming (2000), Dekker (2002), and Salazar (1989) agree: the goal of evaluating safety and quality systems is to measure the effectiveness of the system, not the nature of the results.

Murphy (2003) also believes that safety and quality goals align very well. The following actions were identified by Murphy as having a place in both safety and quality:

- A definition of core processes which are essential for excellence
- Measurement of targeted factors
- Using data to understand the variation in the targeted factors
- Learning from feedback
- Use of data to quantify and measure relationship between system variables
- Solving problems as a method for continuous improvement
- Management plays a significant role in commencing and sustaining process improvements
- Active employee integration of methods in their daily tasks

In the literature, theoretical behavioral connections between safety and quality have been identified. Murphy's (2003) thoughts on the association between an employee's safety behavior and quality performance are explained partially by the Theory of Planned Behavior (Fogarty and Shaw 2010). The theory seeks to explain the immediate antecedents to behavior and aims to predict and explain human behavior in a specific environment. The theory assumes that a person's behavior is based on several things: available alternatives, motivational factors, and attitude and perceptions. Both safety and quality decisions could be explained using the components of the Theory of Planned Behavior as both decision choices depend on alternatives, motivations, and perceptions of employees. However, Murphy (2003) criticizes the theory for its low reliability across scenarios and its lack of consideration for past behavior.

Das et al. (2008) forwards a more basic behavioral theory to explain the relationship between safety and quality. The group refers to Maslow's Hierarchy of Needs, which assumes that the needs at a lower stage (safety) must be satisfied before employees can concentrate on needs at higher levels (quality) (Glickman et al. 2001). However, Das et al. (2008) also note that motivational theory can partially explain why employees who do not feel safe will fail to pursue quality goals. Employees tend to evaluate choices offered to them on the basis of outcomes (Steel and Konig 2006). Outcomes of lowered safety are more likely to benefit the employer (Kaminiski 2001) by saving money on equipment, training and engineered design. Therefore, working in an unsafe setting (saving the company money at the worker's expense) will limit the employee's motivation for pursuing quality-related goals. This is especially true when one considers that in many cases, employees will see little benefit from quality improvement – quality goals will largely add value only to the organization (Das et al. 2008).

Zohar and Erev (2007) also offer a theoretical basis for employee decision-making. Although Zohar and Erev (2007) are speaking from a safety viewpoint, many of their ideas are also true from a quality perspective. The theory discussed is the Expected Utility Theory (EUT), which has been used to explain decision-making under risk and uncertainty for several decades. The fundamental assumption of the EUT is that when people make decisions under risk or uncertainty, they weigh several options and the likelihood of each occurring

(Newell, Lagnado and Shanks 2007). However, the basis of EUT has been challenged by the Prospect Theory (Tversky and Wakker 1995). Prospect Theory hypothesizes that decision makers have a tendency to give more credence to low-probability but high impact events than to high-probability, low impact events. In other words, humans are more sensitive to risk than they are to uncertainty in a decision (Newell, Lagnado, and Shanks 2007).

Zohar and Erev (2007) also discuss safety decision choices from a social realm. These consequences can be classified in two ways: internal outcomes and external outcomes. Internal outcomes affect only the person who is making the decision, while external outcomes will affect others. Zohar and Erev (2007) theorize that in the case of unsafe behavior, the externalities of the decision are typically underweighted by the decision maker in favor of positive internal outcomes such as savings in time and effort and an increase in productivity. This may also be true in cases of quality decisions. In both these situations, the expected outcome of negative safety and quality decisions is clearly favorable over that of more positive safety decisions (Keren et al. 2009; Zohar and Erev 2007).

A final theory which can be used to explain the relationships between safety and quality is the theory of cognitive dissonance (Festinger 1957; Harmon-Jones and Harmon-Jones 2008). The theory falls under the family of motivational theories and aims to understand the relationship between contradicting cognitions or "pieces of knowledge". Operationally, the theory asserts that when people are confronted with the uncomfortable state of having to decide between two conflicting conditions in the workplace (i.e. safety and productivity; quality and cost), the person will attempt to address the conflict in one of three ways (Das et al. 2008): first, ignore their own judgment and follow advice of the supervisor or manager; second, ignore the opinion of management and the supervisor and follow their own judgment; and third, delay action and do nothing until they are forced to make a decision. Of course, the third option does not solve the problem; rather, it just postpones the inevitable decision path until a later time. A fourth option, not addressed by the model, is that where the person has no conflict with their existing knowledge and consequently follow orders from management without any internal conflict.

Given all the factors which have been found to play a role in the decision choices of employees, the hypothesis of many researchers is that organizational factors have the

potential to sway the balance of the dilemma between safe and unsafe decision choices and ultimately, behavior (Brown et al. 2000; Edmondson 1996; Johnson 2007; Neal et al. 2000; Seo 2005; Zohar and Luria 2005). The conflict which forms the basis of this dilemma is tested in the present research.

SAFETY AND QUALITY FROM TWO LEVELS

A second line of research has examined the differences in safety and quality climate between administrative levels. Zohar and Luria (2005) present a multilevel model of safety climate based on a theoretical framework outlined by Zohar (2000, 2003). The model attributes some variation in safety climate to the dynamics of the work group. This model assumes that employees are continually presented with a large number of inconsistent and conflicting demands from both management and supervisors. A second assumption is that although the management may create and develop policies and regulations, the daily implementation of the resulting actions and tasks are left to the supervisor. Supervisors are often left to interpret management mandates with a great deal of flexibility, resulting in variation between supervisory groups.

Thompson et al., (1998) note that managers and supervisors both play roles in promoting workplace safety, albeit in different ways. Managers determine the degree of politics in the organization's work climate. Politics can be defined as actions such as falling for subordinate flattery, hidden agendas, or avoiding unpleasant or controversial matters. From a supervisory level, negative political behavior might include not forwarding unpleasant information to managers or avoiding confrontation with problem employees. In many cases, political behavior is usually classified as a negative attribute because it suggests the needs of the manager are being placed above the needs of the organization (Thompson et al. 1998). In terms of safety, manager actions such as establishing priorities, setting production schedules, and controlling incentives may be influenced by negative workplace politics.

Alternatively, the supervisor's role in safety involves the degree of fairness the supervisors' use in resolving violations of compliance to safety rules. Thompson et al. (1998) refer to the perceived justice given by supervisors to subordinates when employees bring an issue forward to a supervisor. Employees expect supervisors to represent them fairly in the

presence of management. If this does not occur, perceptions of justice will be negatively impacted.   Thompson et al. (1998) also describe tasks which supervisors manage that promote safety. These include: monitoring compliance, providing feedback and providing input to management on employee compliance or failure to comply with organizational policies and procedures. Supervisors also serve as a liaison between employees and management. Conflicts between these two groups can negatively impact interaction programs aimed at improving workplace safety outcomes. Thus, resolving differences in perceptions between the groups should be a priority for managers and supervisors who are serious about improving safety.

Zohar (2008) adds additional details on the relationship between organizational and group level safety climate. He differentiates between formal policies, typically created by management, and enforced policy, implemented mainly by supervisors. He notes that while managers create policies and procedures for implementing policies, it is supervisors who execute the policies. He sees differences between the safety climates of the two groups as an inherent part of a multi-level system. The reason for this is because procedures rarely cover every situation that could possibly occur, therefore, supervisors must make choices on how and which procedures can be practically implemented. Zohar (2008) believes supervisors confront systemic conflicts of organizational goals, which force them to use their own judgment in interpreting and implementing formal procedures, resulting in differences between organizational level (management) climate and group level (supervisor) climate.

Simard and Marchand (1995) point to factors at several levels, including micro and macro organizational levels. They report that micro level factors such as work processes, hazards, and work group cohesiveness contribute to workers' willingness to take safety initiatives. In their work, they found that many micro level factors are influenced by macro-level factors such as managerial support and commitment. However, after an accident, several researchers have noted the difference in perceptions between managers and first-line supervisors and co-workers of the victim. While management personnel generally attribute accidents to attitudes, knowledge, and behaviors of workers, supervisors and colleagues of the victim are more likely to blame the work environment, systemic weaknesses in safety or simple bad luck (Kouabenan 2009; Prussia et al. 2003; Walker 2010). Addressing the

"disconnect" between the management, supervisors, and workers is important not only for the success of workplace safety programs, but also for quality programs (Brown et al. 2000; Das et al. 2008; Prussia et al. 2003).

Psomas et al. (2010) found a link between effective implementation of an ISO based quality system and commitment and support of senior management, internal motivation of the company, and attributes of the company. All of these factors are indicators of organizational climate (Patterson et al. 2005). Howard and Foster (1999) found that human resource management practices which increased employee empowerment increased the perceptions of leadership commitment to quality. Evans et al., (2005) found a significant positive relationship between safety climate and quality climate in a wood-processing environment, but a negative relationship between safety climate and productivity climate and safety-related events. The lack of research related to quality climates limits the amount of research performed at different levels of administration. However, the little research that has been completed in this area has demonstrated that perceptions concerning management's commitment to quality are an important factor in the success of quality management programs in the workplace (Das et al. 2008; Evans et al. 2005; Howard and Foster 1999; Psomas et al. 2010).

This research seeks to build upon the work of Das et al. (2008) and add to the limited research on the relationship between safety and quality climates as interpreted at two levels of administration. In addition, decision choices made by employees in safety and quality scenarios were measured to determine if employee safety decision choices predict employee quality decision choices. A graphical model of the relationships measured is shown in Figure 1.The following research questions guided the collection and analysis of data in this work.

1. Does safety climate predict quality climate at organizational and group levels?
2. Does the level of organizational safety climate predict the level of group safety climate?
3. Does the level of organizational quality climate predict the level of group quality climate?
4. Does organizational and group safety climate predict the employee's decision choice in a quality related decision task?

5. Does organizational and group quality climate predict the employee's decision choice in a safety related decision task?

6. Does an employee's choice of a safe decision predict the choice of a decision which promotes quality?

Figure 1. Model of relationship between safety and quality
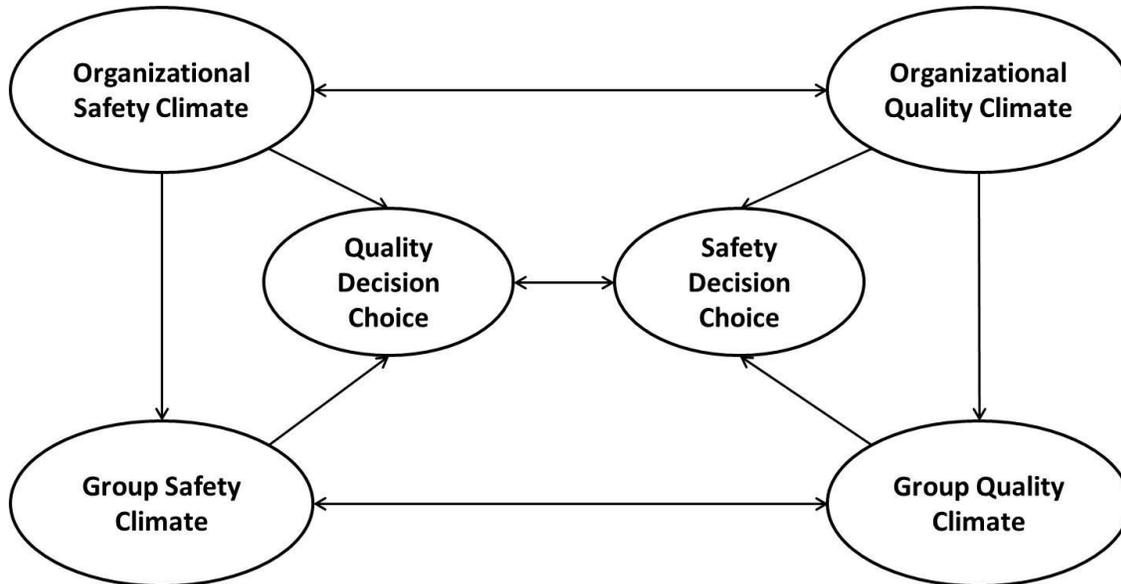
MEASUREMENT OF DATA

Data was gathered in three parts. First, two survey instruments were used to measure the safety and quality climates of three agricultural grain handling organizations. To measure employee perceptions of safety climate, the Organization and Group Level Safety Climate instrument (Zohar and Luria 2005) was used. The instrument was developed and validated by Zohar and Luria (2005) to measure two-level safety climate. The instrument consisted of 16 items measuring the perceptions of employees concerning the relative priority management gives to safety and 16 items which measured the employees' perceptions of the relative priority given to safety by the supervisors. Items were scored on a 5 point scale (1 = Strongly agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly disagree). For analysis, the items were split into two groups: management and supervisory. The quality climate instrument was

constructed based on the validated safety instrument. Items were modified slightly to reflect a quality environment and were scored on the same scale.

Scale items were highly correlated in both safety and quality climate measures, so factor analysis was performed to identify orthogonal variables in each instrument. For reasons of brevity, these data were not included in the manuscript. They are available from the first author by request. Both the organizational and group safety climate variables loaded on one factor. High loadings on each item resulted in the decision to use the aggregated means of individual organizational and group level safety climate responses to represent one universal safety climate factor. Scale reliability was evaluated using Cronbach's Alpha coefficient and both met generally acceptable standards for reliability with a coefficient of 0.95 for the organizational level and 0.97 for the group level (Bryman and Cramer 2009).

Similar results were noted for quality climate measures. As with the safety climate scales, the instrument was divided into two components for analysis: 16 items were used to measure organizational quality climate and 15 items for group quality climate. Both sets of items loaded on one factor. Factor loadings on each were high (above 0.67 for organizational and above 0.71 for group level) and these values led to the decision to aggregate individual means for the variables into one universal factor to represent organizational quality climate and one universal factor representing group quality climate. Scale reliability was evaluated using Cronbach's Alpha coefficient and both scales were found to meet generally accepted standards for scale reliability with a value of 0.96 for the organizational scale and 0.97 for the supervisory scale.

The second portion of the study measured employee decision making patterns in a safety decision task and a quality decision task. The safety decision scenario was created based on a fundamental safety concern in all work environments – the failure to follow standard operating procedures (SOPs) (Keren et al. 2009; Zohar and Erev 2007). The scenario was selected to reflect the response of an employee when he or she is presented with a potential shortcut opportunity. The dilemma presented occurs commonly in the grain handling industry – the bridging of out of condition grain as it is unloaded from a grain storage container to a transportation vehicle (Brandon 2009; Freeman et al. 1998; Kingman and Field 2005; Roberts and Field 2010).

Following SOPs will resolve the issue, but require additional time, slowing productivity and delaying shipments to clients. Fixing the problem by taking the shortcut presents a major engulfment hazard to the employee. The dilemma presented to the employee asks him or her to decide whether to follow safety procedures and take additional time or fix the problem quickly but with an increased risk of injury or death.

The quality decision-making task investigated in this work was employee decisions concerning the management and storage of wet corn. The scenario asks employees to make choice – do they follow directives from management and dump the wet corn onto an unmanaged pile on the ground or do they take action to better preserve the quality of the product? Although this action is fairly straightforward, it illustrates implications for a larger question that can be applied across all industries – does the employee follow the instructions from the supervisor and management, even if these do not promote high quality processes, or do they make a decision to disregard the management and supervisor in favor of a more quality-oriented decision?

Decision-making data was collected using the process-tracing method of measuring decisions. This technique traces the information gathering process by recording data on the information viewed by the employee during a decision task. Mintz (2004) reviews this process in more depth.

The software platform used was Decision Mind™, a computerized decision-making simulation. The simulation employs decision process-tracing by recording several key attributes of the decision making process, including: 1) sequence of information gathered, 2) the number of items viewed 3) the amount of time needed to complete the decision-making task, and 4) the choice. The decision structure is presented in a matrix format with a set of alternatives and a set of dimensions. Dimensions represent factors which may influence the decision choice. Both safety and quality decisions were drawn from published literature and current information available about both decision scenarios in the research and popular press (Bern and Brumm 2003; Brandon 2009; Reed 2006; Roberts and Field 2010). Dimensions in the safety decision scenario included: productivity, safety, supervisor's opinion, and peer pressure. Dimensions for the quality decision scenario included: storage risk, customer service, company policy, and cost to company. Alternatives define the choices available to

the participant and information is gathered by viewing the dimensions. The participant is asked to choose one alternative based on information acquired from the dimensions (Mintz 2004).

The safety and quality scenarios were developed and critiqued by a panel of experts in agricultural safety and grain elevator operations using a modified Delphi method (Linstone and Turoff 2002). Scenarios were pilot tested on a small group with a moderate knowledge of grain elevator operations. The text of the both scenarios presented to employees is shown in the appendix. The research discussed in this case focused on decision choices of employees. Keren, Freeman and Schwab (2006), Keren et al. (2009) and Mills (2007) provide more information on the use and analysis of decision dimensions.

RESULTS AND DISCUSSION

Participants were employees of three Midwestern grain handling facilities. Employees who would be subject to safety and quality-related decisions in their daily jobs (i.e. those who worked clerical and administration were excluded) were offered the opportunity to participate in the project. Data was collected from March until May 2010. The sample consisted of 142 males and 35 females for a total sample size of 177. The age of participants ranged from below 21 to over 61, with the most common response being 41-50 years of age. Most participants had been on the job either less than three years (38.5%) or had been with the organization more than 10 years (35.2%). Nearly all (98%) had completed high school, with some (66%) completing at least some college.

Using Statistical Package for the Social Sciences (SPSS 18.0) bivariate two-tailed correlations were calculated to illustrate the direction and strength of the relationship between variables and these data are presented in Table 1.

Table 1. Bivariate correlations between variables

Variable[a]	1	2	3	4	5	6
Organizational safety climate	1					
Group safety climate	.774**	1				
Organizational quality climate	.654**	.691**	1			
Group quality climate	.185*	.225**	.242**	1		
Safety decision	-.219**	-.185*	-.296**	-.035	1	
Quality decision	-.163*	-.133	-.217**	-.003	.141	1

[a]$n = 185$; **=$p<0.01$; *=$p<0.05$

   To measure the amount of variance explained in the dependent variable by the independent variable, the coefficient of determination is used. The value is commonly referred to as r^2. Values for each relationship studied are shown in Figure 2.

Figure 2. Safety and quality model with coefficient of determination (r^2) values[a]
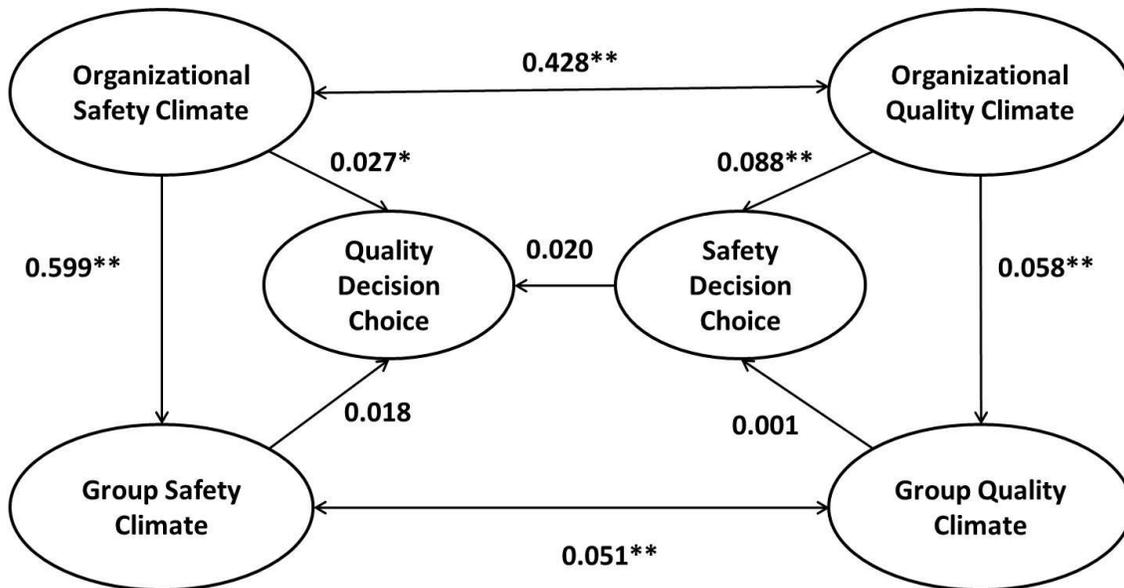
[a]values represent r^2 values; **= $p< 0.01$; *= $p<0.05$

   Data were able to answer the research questions conclusively. The first research question asked whether organizational and group safety climate could predict organizational

and group quality climate. In both pairs of variables relationships between safety climate and quality climate exhibited a positive and significant relationship, indicating that a positive safety climate is more likely to encourage a positive quality climate. The strength of relationships between organizational safety climate and organizational quality climate were surprising, given that few grain handling facilities think the two goals have anything in common. Another noteworthy finding was the relationship between safety and quality climates at the group level. Although it is a significant relationship, the strength of the two climates from a work group perspective is much less than the same relationship at the organizational tier. The finding suggests that employees do not connect the administration of quality with their supervisors nearly as much as they do with their management team.

This finding aligns with Deming's (2000) thoughts on the role of management the development of and implementation of quality processes within an organization. Yet, although management does play a large role in setting quality protocols and pushing through organizational changes which result from quality management systems, on a daily basis it will be the supervisors who implement the routine tasks and procedures. Strengthening the employee perceptions of the connection between group quality climate and their supervisor should be a priority for leaders who wish to introduce quality management systems to their employees.

The second and third research questions concerned levels of safety and quality climate at two administrative levels. The significant positive relationships noted between organizational and group safety climates confirmed a similar relationship reported by Johnson (2007), Thompson et al. (1998), and Zohar and Luria (2005). The role of management in setting organizational safety priorities and influencing work group priorities for safety procedures makes both logical and theoretical sense.

The same relationship strength does not exist for quality climate at both tiers of administration. Although Howard and Foster (1999) observed that quality tends to flourish under strong management commitment to the cause, little additional empirical evidence has confirmed this. Although a significant positive relationship was found between organizational and group level quality climate in this research, from a practical standpoint, less than 6% of the variance in group level climate was explained by organizational quality

climate. This suggests that perceptions of management's commitment to quality have less influence on how employees' feel about their supervisor's relative commitment to quality than was observed for safety climate.

The final two research questions concern the relationships of quality climate with safety decision choices and safety climate with quality decision choices. The data offer both expected and unexpected findings. As specified in Maslow's theory of human needs (Maslow 1970) and previous research (Das et al., 2008), a positive significant relationship was noted between organizational safety climate and positive quality decisions, indicating that employees make decision choices which encourage quality when they feel positively about safety. Again, this supports the quality theories offered by Deming (2000) and Howard and Foster (1999). However, the limited involvement that most management teams have in daily employee decisions, particularly those involving quality, makes this finding somewhat unexpected.

In addition, the strength of the organizational finding is even more unexpected in light of the lack of findings at the group tier. The relationship between group safety climate and quality decision choices was not significant, indicating little or no connection between how quality is perceived within the work group and the decision choice in a quality decision task. Given the frequent interaction between supervisors and employees, the lack of a significant relationship is unexpected.

Additionally, a significant relationship was noted between organizational quality climate and employee safety decisions, even though it lacked a theoretical basis. As with the safety climate and quality decision relationship, no significant group level relationship with safety decision choice was observed. In the workplace environment, this could be partially explained by the properties of many workplace quality management systems. An integral part of such systems are detailed descriptions on employee actions, tasks, and daily duties, including handling emergencies and out-of-specification products. Perhaps the discipline of the quality system also promotes discipline within the safety realm as well as is suggested by several researchers (Brown 1996; Das et al. 2008; Salazar 1989). The finding warrants further investigation to determine if this is an isolated finding or one which is true across many workplace facilities.

LIMITATIONS, RECOMMENDATIONS, and CONCLUSIONS

Like all research involving humans, this work is subject to several limitations. The small sample and the cross-sectional data collection may limit the extrapolation to other situations and work environments. In addition, a new tool was used to collect decision-making data and because of its newness, it may add measurement error to the data collection process. Quality climate is a concept that has not been tested repeatedly, potentially adding unwanted and uncontrolled error to the results. This work was the first attempt at developing stronger theoretical connections between safety and quality in a grain handling environment. Therefore, does not begin to establish the kind of evidence needed for theory development and this is fully acknowledged by the researchers. Moreover, the work tested only one safety scenario and one quality scenario. Consequently, the results cannot be generalized to other work tasks although the broad decision concepts could be tested in other situations to address this weakness. Finally, decision simulations measure employee intentions and not employee behavior, so employees may behave in a different way than how they responded to the decision scenario. This is an inherent limitation to leading indicators of both safety and quality as well as with decision-making research.

Findings from this research suggest that the linkages between safety and quality climates are in place, although not in all levels. More work is needed to connect quality climate to the work group level, where many decisions regarding quality tasks and work procedures are made. Increasing the communication between departments of safety and quality may partially address this gap, but building the bridge between safety and quality is a long term proposition, especially in the field of agricultural handling, where the two concepts have not historically had a strong association. A systemic approach to managing safety and quality in a grain handling environment may improve performance in both areas. Managing the two from separate perspectives and departments does not appear to be a good methodology, given their apparent connectedness.

Future research should continue to investigate the linkages between workplace safety and quality, focusing on ways to align supervisors more closely with daily quality processes. In addition, the inter-connected relationship between quality management systems and safety decisions calls for further investigation, both from an operational perspective as well as a

theoretical viewpoint. Future research should also expand the decision-making scenarios, especially in the area of quality management systems. Human factors play a major role in the success of occupational safety programs and quality management systems (Chrusciel 2004; Goetsch 2008; Lunning and Marcelis 2007), but to better understand these human factors of failure and success in quality management systems, our understanding of this role must increase.

REFERENCES

Brandon, H. August 4, 2009. Grain storage – deadly dangers. *Delta Farm Press*. Downloaded August 6, 2009 from: http://deltafarmpress.com/com/grain-storage-0804/

Bern, C.J. and Brumm, T.J. 2003. Moisture content measurement. In *Encyclopedia of Agricultural, Food, and Biological Engineering*, D.R. Heldman, Ed. New York: NY: Marcel Dekker, Inc.

Bern, C.J., Quick, G., and Herum, F.L. 2003. Harvesting and postharvest management. In *Corn: Chemistry and technology*, P.J. White and L.A. Johnson, Eds. St Paul, MN: American Association of Cereal Chemists, Inc.

Brown, K.A. 1996. Workplace safety: A call for research. *Journal of Operations Management*, 14(2), 157-171.

Brown, K.A., Willis, P.G. and Prussia, G.E. 2000. Predicting safety employee behavior in the steel industry: Development and test of a sociotechnical model. *Journal of Operations Management,* 18(4), 445-465.

Bureau of Labor Statistics. 2010. Census of fatal occupational injuries summary, 2009. Downloaded August 23, 2010 from: http://www.bls.gov/news.release/cfoi.nr0.htm.

Capmany, C., Hooker, N.H., Teofilo, O., and Tilburg, A. 2000. ISO 9000 – A marketing tool for U.S. agribusiness. *International Food and Agribusiness Management Review*, 3(1), 41-53.

Chapman, L.J. and Husberg, B. 2008. Agriculture, forestry, and fishing sector. *Journal of Safety Research*, 39(2), 171-173.

Cooper, M.D. and Phillips, R.A. 2004. Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, 35(5), 497-512.

Das, A., Pagell, M., Behm, M., and Veltri, A. 2008. Toward a theory of the linkages between safety and quality. *Journal of Operations Management*, 26(4), 521-535.

Dekker, S.W.A. 2002. Reconstructing human contributions to accidents: The new view on error and performance. *Journal of Safety Research*, 33(3), 371-385.

Deming, W.E. 2000. *Out of the crisis*. Cambridge, MA: The MIT Press.

Edmondson, A.C. 1996. Learning from mistakes is easier said than done: Group and organizational influences on the detection and correction of human error. *Journal of Applied Behavioral Science*, 32(1), 5-28.

Evans, D.D., Michael, J.H., Wiedenbeck, J.K., and Ray, C.D. 2005. Relationships between organizational climates and safety-related events at four wood manufacturers. *Forest Products Journal*, 55(6), 23-29.

Festinger, L. 1957. *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Fogarty, G.J. and Shaw, A. 2010. Safety climate and the Theory of Planned Behavior: Toward the prediction of unsafe behavior. *Accident Analysis and Prevention*, 42(5), 1455-1459.

Food and Drug Administration. 2010. Recalls, Market Withdrawals, and Safety Alerts. FDA: United States Health and Human Services: Washington, D.C. Accessed on August 24, 2010 from http://www.fda.gov/Safety/Recalls/default.htm

Ford, J.K., Schmitt, N., Schechtman, S.L., Hults, B.M, and Doherty, M.L. 1989. Process tracing methods: contributions, problems, and neglected research questions. *Organizational Behavior and Human Decision Processes*, 43, 75-117.

Freeman, S.A., Kelley, K.W., Maier, D.E., and Field, W.E. 1998. Review of entrapments in bulk agricultural materials at commercial grain facilities. *Journal of Agricultural Safety and Health*, 4(2), 119-130.

Glickman, C.D., Gordon, S.P. and Ross-Gordon, J.M. 2001. Adult and teacher development within the context of the school: Clues for supervisory practice. In *Supervision and*

Instructional Leadership: A Developmental Approach, C.D. Glickman, S.P. Gordon, and J.M. Ross-Gordon, Eds. Needham Heights, MA: Allyn and Bacon.

Goetsch, D.L. 2008. *Occupational safety and health for technologists, engineers, and managers, 6th edition.* Upper Saddle River, NJ: Pearson/Prentice Hall.

Harmon-Jones, E. and Harmon-Jones, C. 2008. Cognitive dissonance theory: An update with a focus on the action-based model. In *Handbook of motivation science*, J.Y. Shah and W.L. Gardner, Eds. New York, NY: Guilford Press.

Harris, G. 2009, March 26. Investigators find source of many foods untraceable. *New York Times*. Accessed on October 13, 2009 from http://www.nytimes.com/2009/03/26/health/policy/26fda.html

Hellevang, K.J. 1995. Grain moisture content effects and management. Document AE-905. Fargo, ND: North Dakota State University Extension Service. Downloaded April 21, 2009 from: http://www.ag.ndsu.nodak.edu/abeng/pdffiles/ae905.pdf

Hofmann, D.A., Jacobs, R. and Landy, F. 1995. High reliability process industries: Individual, micro, and macro organizational influences on safety performance. *Journal of Safety Research,* 26(3), 131-149.

Howard, L.W. and Foster, S.T. 1999. The influence of human resource practices on empowerment and employee perceptions of management commitment to quality. *Journal of Quality Management*, 4(1), 5-22.

Hurburgh, C.R. and Lawrence, J.D. 2003. The need for QMS. *Resource: Engineering and Technology for a Sustainable World,* 10(9), September 2003, 29.

Johnson, S.E. 2007. The predictive validity of safety climate. *Journal of Safety Research*, 38(5), 511-521.

Kaminski, M. 2001. Unintended consequences: organizational practices and their impact on workplace safety and productivity. *Journal of Occupational Health Psychology*, 6, 127-138.

Keren, N., Mills, T.R., Freeman, S.A., and Shelley, M.C. 2009. Can level of safety climate predict level of orientation toward safety in a decision making task? *Safety Science*,47(10), 1312-1323.

Kingman, D.M. and Field, W.E. 2005. Using fault tree analysis to identify contributing factors to engulfment in flowing grain in on-farm grain bins. *Journal of Agricultural Safety and Health*, 11(4), 395-405.

Kouabenan, D. R. 2009. Role of beliefs in accident and risk analysis and prevention. *Safety Science,* 47(6), 767-776.

Laux, C.M. 2007. The impacts of a formal quality management system: A case study of implementing ISO 9000 at Farmer's Cooperative Company, Iowa. Unpublished doctoral dissertation, Iowa State University. Dissertation Abstracts International B68/07.

Laux, C.M. and Hurburgh, C.R. 2010. Using quality management systems for food traceability. *Journal of Industrial Technology*, 26(3).

Lehtola, C.J., Brown, C.M. and Becker, W.J. 2008. Grain handling facilities – OSHA standard 1910.272. (ABE208). Gainesville, FL: Institute of Food and Agricultural Sciences, University of Florida. Downloaded June 16, 2008 from http://edis.ifas.ufl.edu/pdffiles/OA/OA11000.pdf.

Linstone, H.A. and Turoff, M. 2002. The Delphi method: Techniques and applications. Online textbook, ISBN 0-201-04294-0. Newark, NJ: New Jersey Institute of Technology. Downloaded August 4, 2008 from: http://is.njit.edu/pubs/delphibook/.

Lunning, P.A. and Marcelis, W.J. 2007. A conceptual model of food quality management functions based on a techno-managerial approach. *Trends in Food Science and Technology*, 18, 159-166.

Martin, A. and Moss, M. 2009, March 30. Salmonella in Pistachios Spurs Recall. *The New York Times*. Accessed on August 18, 2010 from http://www.nytimes.com/2009/03/31/business/31nuts.html.

Maslow, A. 1970. *Motivation and personality* (2nd ed.). New York: Harper and Row.

Mintz, A. 2004. Foreign policy decision making in familiar and unfamiliar settings: An experimental study of high-ranking military officers. *Journal of Conflict Resolution*, 48(1), 91-104.

Miranowski, J.A., Jensen, H.H., Batres-Marquez, P., and Ishdorj, A. 2004. *Product differentiation and segregation in agricultural systems: Non-Genetically modified*

and specialty corn and soybean crops in Iowa. (Paper No. 04-WP 354). Ames, IA: Center for Agricultural and Rural Development.

Moss, M. 2009, February 9. Peanut case shows holes in safety net. *The New York Times.*Accessed on October 13, 2009 from: http://www.nytimes.com/2009/02/09/us/09peanuts.html

Murphy, D.J. 2003. Human behavior theories, models, and applications. In D.J. Murphy (Ed), *Looking beneath the surface of agricultural safety and health*, (pp. 45-67). St. Joseph, Michigan: American Society of Agricultural Engineers.

National Safety Council. 2007. *Plain Facts About the Agricultural Industry.* Downloaded February 11, 2010 from: http://www.nso.org/issues/agri.indus/htm.

Naveh, E. and Marcus, A. 2007. Financial performance, ISO 9000 standard and safe driving practices effects on accident rate in the U.S. motor carrier industry. *Accident Analysis and Prevention*, 39(4), 731-742.

Neal, A., Griffin, M.A., and Hart, P.M. 2000. The impact of organizational climate on safety climate and individual behavior. *Safety Science*, 34(1-3), 99-109.

Newell, B.R., Lagnado, D.A. and Shanks, D.R. 2007. Straight choices: The psychology of decision making. New York: Taylor and Francis Group.

Patterson, M.G., West, M.A., Shackleton, V.J., Dawson, J.F., Lawthom, R., Maitlis, S., Robinson, D.L., and Wallace, A.M. 2005. Validating the organizational climate measure: Links to managerial practices, productivity, and innovation. *Journal of Organizational Behavior*, 26(4), 379-408.

Payne, J.W., Bettman, J.R., and Johnson, E.M. 1993. *The adaptive decision-maker.* Cambridge: Cambridge University Press.

Prussia, G.E., Brown, K.A., and Willis, G.P. 2003. Mental models of safety: Do managers and employees see eye to eye? *Journal of Safety Research*, 33(2), 143-156.

Psomas, E.L., Fotopoulos, C.V. and Kafetzopoulos, D.P. 2010. Critical factors for effective implementation of ISO 9001 in SME service companies. *Managing Service Quality*, 20(5), 440-457.

Rao, S.S., Ragu-Nathan, T.S., and Solis, L.E. 1997. Does ISO 9000 have an effect on quality management practices? An international empirical study. *Total Quality Management*, 8(6), 335-346.

Reed, C.R. 2006. *Managing stored grain to preserve quality and value.* St. Paul, Minnesota: American Association of Cereal Chemistry International.

Roberts, M. and Field, B. 2010. A disturbing trend: U.S. grain entrapments on the increase. *Resource: Engineering and Technology for a Sustainable World,* July/August 2010, 10-11.

Salazar, N. 1989. Applying the Deming philosophy to the safety system. *Professional Safety*, 34(12), 22-27.

Simard, M. and Marchand, A. 1995. A multilevel analysis of organizational factors related to the taking of safety initiatives by work groups. *Safety Science*, 21(2), 113-129.

Seo, D.C. 2005. An explicative model of unsafe work behavior. *Safety Science,* 43(3), 187-211.

Steel, P., and Konig, C.J. 2006. Integrating theories of motivation. *Academy of Management Review*, 31(4), 889-913.

Thakur, M. 2010. Operational techniques for implementing traceability in bulk product supply chains. Unpublished doctoral dissertation, Iowa State University. AAT 3413717.

Thakur, M. and Hurburgh, C.R. 2009. Framework for implementing traceability system in the bulk grain supply chain. *Journal of Food Engineering*, 95(4), 617-626.

Thakur, M. Mosher, G.A., Brown, B., Bennet, G.S., Shepherd, H.E., and Hurburgh, C.R. 2009. Traceability in the bulk grain supply chain. *Resource: Engineering and Technology for a Sustainable World*, April/May, 20-22.

Thompson, R., Hilton, T., and Witt, A. 1998. Where the rubber meets the shop floor: A confirmatory model of management influence on workplace safety. *Journal of Safety Research*, 29(1), 15-24.

Tversky, A. and Wakker, P. 1995. Risk attitudes and decision weights. *Econometrica*, 63(6), 1255-1280.

United States Department of Labor 2008. *Workplace injuries and illnesses in 2007*. Bureau of labor statistics: Washington, D.C. Downloaded March 16, 2009 from: http://www.bls.gov/news.release/pdf/osh.pdf

Walker, G.W. 2010. A safety counterculture challenge to a "safety climate". *Safety Science*, 48(3), 333-341.

Zohar, D. 2000. A group-level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology*, 85(4), 587-596.

Zohar, D. 2002. Modifying supervisory practices to improve subunit safety: A leadership-based intervention model. *Journal of Applied Psychology*, 87(1), 156-163.

Zohar, D. 2003. The use of supervisory practices as leverage to improve safety behavior: A cross-level intervention model. *Journal of Safety Research*, 34(5), 567-577.

Zohar, D. 2008. Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46(3), 376-387.

Zohar, D. and Erev, I. 2007. On the difficulty of promoting workers' safety behavior: Overcoming the underweighting of routine tasks. *International Journal of Risk Assessment and Management*, 7(2), 122-136.

Zohar, D. and Luria, G. 2005. A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4) 616-628.

Chapter 6. General Conclusions and Recommendations for Future Work

GENERAL REVIEW OF CONCLUSIONS

The overriding goal of this research was to determine the association between perceptions of employee trust, safety, and quality and the decision choice and decision-making process of grain elevator employees at two levels of administration. Broadly, the research questions asked:

1. Does employee trust predict safety and quality climates?
2. Does employee trust predict employee decision choices in safety and quality decision-making tasks?
3. Does employee trust predict the process employees use to make their decision choices in safety and quality decision-making?
4. Does safety climate predict employee decision choices in safety and quality decision tasks?
5. Does quality climate predict employee decision choices in quality and safety decision tasks?
6. Do safety or quality climates predict the process employees use to make their decision choices?
7. Do organizational safety and quality climates predict group level safety and quality climates?

All relationships were explored at the organizational level (with management) and at the group level (with supervisors). At the organizational level, the relationship of trust with safety climate was positive and significant, indicating that positive employee perceptions of trust predicted positive employee perceptions of safety commitment by management. This was not an unexpected finding, as previous literature has implied such a relationship. The relationship between group trust and group safety climate was also positive and significant, demonstrating that employee trust in their supervisors predicted a more positive viewpoint concerning the supervisors' commitment to safety. This finding has been suggested in previous work, but never explicitly tested. Data suggest an important role for behavioral trust in establishing and maintaining high level

organizational and group safety climates. Although organizational and safety climates explained less than 25% of the variance in organizational and group trust, these values represent a noteworthy finding when attempting to predict human behavior.

Relationships between trust and quality climates showed positive and significant relationship at only one of the two levels. Organizational level quality climate and trust revealed a significant, positive relationship, with the employees' perceptions of the management's commitment to quality climate explaining almost 50% of the variance in employees' trust in the management. However, no significant relationship was noted at the group level. This was an important finding, both because of the strong relationship at the organizational level and the lack of relationship at the group level. The data suggest that while trust in management plays a large role in the development of a positive quality climate, the role of trust at the supervisory level concerning the development of a positive quality climate is essentially zero.

Results testing the influence of trust on safer decision choices showed a clear pattern. Organizational trust could not significantly predict the selection of a safer decision choice, but a significant relationship was noted between trust and a safer decision choice at the group tier. The pattern revealed in this case is not unexpected as it would be logical to expect the supervisor to have a greater impact on employee decision choices than the management. This is in part because of the greater interaction between supervisors and employees than is typically noted between the management and employees.

Only one safety search dimension played a significant role in the relationship between decision-making process and trust and this was peer pressure. A positive and significant relationship was noted between positive peer pressure and organizational trust. A similar finding was noted in previous research (Keren et al., 2009), but in previous work peer pressure was framed negatively, while in this research, peer pressure was framed as a positive influence on safety. No significant relationships between safety search indices were noted at the group level.

The quality data showed different patterns than did the safety data. A significant, positive relationship was noted between trust and quality climate, but only at the organizational level, indicating that a higher degree of trust in management predicted more positive perceptions of quality, but that no significant relationship existed between quality climate and trust of supervisors. Organizational trust did not significantly predict the choice of a quality-oriented decision. At the group tier, only consistency was able to predict a quality-oriented decision-making choice. Group trust and group credibility showed no significant relationship with quality decision choice. Quality climate could significantly predict a more positive quality decision choice at the organizational tier, but not at the group tier.

Organizational and group trust, consistency, and credibility perceptions did not predict a higher orientation toward quality in the decision-making process. Nor did a more positive organizational quality climate predict a stronger emphasis on quality during the quality decision-making task. However, group quality climate showed a significant and positive relationship with three of the four decision indices – storage risk, company policy, and cost to company. The increased emphasis on storage risk indicates that employees were considering quality factors while making the decision, but the emphasis on company policy and cost to company indicates that the decision choice was not without conflict. The importance of following company policy and saving the company money were also powerful factors in the decision-making choice.

The relationship between safety and quality in the grain elevator environment showed several significant patterns. Although safety climate significantly predicted quality climate at both organizational and group tiers, the relationship was much stronger at the organizational tier (explaining 42.8% of the variance at the organizational tier, but only 5.1% at the group tier). Organizational climate was shown to predict group climate for safety and quality, indicating that management priorities for safety and quality carries down to the work group. The stronger effect (nearly 60% of variance explained) was noted for safety. Quality showed a significant, but weaker (5.8% of variance explained) relationship. Furthermore, safety climate significantly predicted a more positive quality

decision choice at the organizational tier, but not at the group tier. The same pattern was noted for the prediction of quality climate and a safer decision choice, with more positive perceptions of quality predicting the choice of a safer decision alternative.

General conclusions from this work emphasize several main points:

- Trust plays a role in safety climate and quality climate
- The role of trust differs by tier of administration and may have different effects on employee decision-making choices at each tier
- Trust has a significant predictive relationship with decision choice for safety, but not with quality decisions
- Safety climate significantly predicts safety decision choice at both organizational and group tiers
- Organizational quality climate predicts a quality decision choice, but group quality climate does
- Safety climate predicts quality climate but only at the organizational level
- Organizational climates influence climates within the work group
- Organizational safety climate predicts a more positive quality decision choice
- Organizational quality climate predicts the choice of a safer decision alternative

LIMITATIONS

Many of the limitations of this work have been discussed in the manuscripts, but another review of them will remind the reader of the constraints of the conclusions noted above. The participants for this research volunteered, in some cases after several other levels (i.e. supervisors, management, executive team) had approved the research. This limited the sample size and introduced significant selection bias. Although an attempt was made to collect data from grain handling organizations with a variety of organizational climates, encouraging participation was a continuous challenge throughout the project.

Another reason for the small sample size was the multi-step, complex, and unfamiliar data collection process. Participants read through one consent document, completed three questionnaires, and two decision simulations. Although specific written directions were

provided to each participant, some measurement error certainly exists. Missing and incomplete data points affected approximately 15% of the data collected. The data collection process may have prevented other employees from taking part, adding additional selection bias.

The researcher was not present while employees completed questionnaires and decision scenarios. Although it is assumed that employees completed all parts of the data instruments independently, this cannot be guaranteed. As with all human-completed research instruments, the assumption is that participants responded honestly and thoughtfully to both the questionnaires and the decision scenarios. In addition, the population in the sample is not known for their computer literacy. All research instruments were computerized and this may have affected their understanding of the data collection process.

The research measured specific actions from a hypothetical perspective. Participant responses represent intentions, not actual behavior. In addition, each decision scenario measured the participants' response to one scenario and cannot be generalized to other situations in the workplace concerning safety and quality. Research instruments are subject to the normal limitations of using questionnaires and human response data collection.

RECOMMENDATIONS FOR FUTURE WORK

This research was the first to measure safety and quality climate with decision-making scenarios in the grain handling environment. Although it has provided some initial findings, it has raised even more questions. Some of these can be addressed by further research. Several of these have been recommended in the manuscripts. Additional recommendations for future research include:

- The safety scenario framed supervisor opinion negatively and peer pressure positively. Future research could reverse the frame of these dimensions and compare decision choices and decision-making processes.
- The development of a quality climate questionnaire designed specifically for quality management in agricultural environments is needed. With this instrument, studying

the constraints of QMS adoption within the agricultural handling industry could be measured more directly.

- The decision data and search index dimensions along with existing research literature can be used to begin to quantitatively estimate paths for an entire safety or quality system using tools such as Event Tree Analysis or Fault Tree Analysis.

- Additional work on why employees continue to behave in unsafe ways in dangerous workplaces is needed. Both quantitative and qualitative research could prove valuable in understanding and preventing unsafe behaviors by employees.

- The role of employees in the development and implementation of quality management systems is not well understood. Successful implementation of QMS in the agricultural handling industry will depend on knowledge in this area.

Agricultural safety and the management of quality are both perennial issues of grain handling facilities. Understanding the employees' perceptions and how they influence workplace behavior and actions will be an important part of improving the management of both safety and quality. This research only begins to reveal what knowledge is needed, but data collected for this research has established the grounding for further work in this area.

Appendix A
Management Behavior Climate Assessment

Please indicate your thoughts on the behavior of the top management team in your organization by marking the most appropriate number. **Mark your answers in the following ways: 1 = Always or almost always; 2 = Usually; 3 = Occasionally; 4 = Seldom; and 5 = Rarely or never.**

Please answer the following questions about the top management team in your organization.

	The top management team in this organization:	**1 = Always or almost always** **2 = Usually** **3 = Occasionally** **4 = Seldom** **5 = Rarely or never**				
1.	Are consistent in their dealings with various and different individuals.	1	2	3	4	5
2.	Tell the same story to each person they speak to.	1	2	3	4	5
3.	"Stay the course" and persist, over time, in the actions they have decided upon.	1	2	3	4	5
4.	Will have the same viewpoint tomorrow as they do today.	1	2	3	4	5
5.	Share relevant information.	1	2	3	4	5
6.	Follow through with actions consistent with what they have said	1	2	3	4	5
7.	Act in the same way, even in different environments.	1	2	3	4	5
8.	Say the same thing from one time to the next.	1	2	3	4	5
9.	Make sure information they share is truthful.	1	2	3	4	5
10.	Act as they said they would in past statements.	1	2	3	4	5
11.	Act the same toward those they know personally as they do toward those they do not know.	1	2	3	4	5
12.	Are open with relevant information.	1	2	3	4	5
13.	Demonstrate respect for their commitments by their actions.	1	2	3	4	5
14.	Make sure that what they say will take place actually occurs.	1	2	3	4	5
15.	Do what they say they will do.	1	2	3	4	5
16.	Deliver on their commitments.	1	2	3	4	5
17.	Provide correct information about past behavior.	1	2	3	4	5
18.	Follow through on promises.	1	2	3	4	5
19.	Carry out actions they have said would be taken.	1	2	3	4	5
20.	State future results or outcomes accurately.	1	2	3	4	5

Please indicate your thoughts on the behavior of your supervisor(s) by marking the most appropriate number. **Mark your answers in the following ways: 1 = Always or almost always; 2 = Usually; 3 = Occasionally; 4 = Seldom; and 5 = Rarely or never.**

	My supervisor(s):	1 = Always or almost always 2 = Usually 3 = Occasionally 4 = Seldom 5 = Rarely or never				
21.	Is consistent in his/her dealings with various and different individuals.	1	2	3	4	5
22.	Tells the same story to each person he/she speaks to.	1	2	3	4	5
23.	"Stays the course" and persists, over time, in the actions he/she has decided upon.	1	2	3	4	5
24.	Will have the same viewpoint tomorrow as he/she does today.	1	2	3	4	5
25.	Shares relevant information.	1	2	3	4	5
26.	Follows through with actions consistent with what he/she has said	1	2	3	4	5
27.	Acts in the same way, even in different environments.	1	2	3	4	5
28.	Says the same thing from one time to the next.	1	2	3	4	5
29.	Makes sure the information he/she shares is truthful.	1	2	3	4	5
30.	Acts as he/she said they would in past statements.	1	2	3	4	5
31.	Acts the same toward those he/she knows personally as he/she does toward those he/she does not know.	1	2	3	4	5
32.	Is open with relevant information.	1	2	3	4	5
33.	Demonstrates respect for his/her commitments by his/her actions.	1	2	3	4	5
34.	Makes sure that what he/she says will take place actually occur.	1	2	3	4	5
35.	Does what he/she says they will do.	1	2	3	4	5
36.	Delivers on his/her commitments.	1	2	3	4	5
37.	Provides correct information about past behavior.	1	2	3	4	5
38.	Follows through on promises.	1	2	3	4	5
39.	Carries out actions he/she has said would be taken.	1	2	3	4	5
40.	States future results or outcomes accurately.	1	2	3	4	5

Please mark next to the characteristic which best describes you.

41. What is your gender?   _____ Male
                                             _____ Female

42. What is your age?   _____ Under 21 years
                                             _____ 21 to 30 years
                                             _____ 31-40 years
                                             _____ 41-50 years
                                             _____ 51-60 years
                                             _____ 61 years or more

43. How long have you worked for this organization?
                                             _____ Less than 1 year
                                             _____ 1-3 years
                                             _____ 3-5 years
                                             _____ 5-10 years
                                             _____ 10-15 years
                                             _____ More than 15 years

44. How long have you worked under your current supervisor?
                                             _____ Less than 1 year
                                             _____ 1-3 years
                                             _____ 3-5 years
                                             _____ 5-10 years
                                             _____ More than 10 years

45. How much education have you completed?
                                _____ Some high school
                                _____ High school diploma or equivalent
                                _____ Vocational/ Comm. College Program
                                _____ Some College
                                _____ Bachelor's degree
                                _____ Graduate degree

46. How often do you receive safety training as part of your work?
                                _____Weekly sessions
                                _____ Twice-monthly sessions
                                _____ Monthly sessions
                                _____ Several times a year
                                _____ Yearly
                                _____ Less than once a year
                                _____ Once – when I started my job here

47. How fairly do you feel you are paid for what you do in this organization?

____ Completely fair
____ Generally fair
____Somewhat fair
____ Not very fair
____ Not at all fair

48. In general, how satisfied are you with your job?

____ Completely satisfied
____ Generally satisfied
____ Somewhat satisfied
____ Not very satisfied
____ Not at all satisfied

Appendix B
Organization and Group Level Safety Climate

Please answer the questions below by circling the number which best matches your opinion on the safety climate in this organization. **Mark your answers in the following ways: 1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, and 5 = Strongly disagree.**

Organizational-Level Safety Climate

Please answer the following questions about your organization's top management team.

Top management in this organization . . .	1 = Strongly agree 2 = Agree 3= Neutral 4 = Disagree 5 = Strongly Disagree				
React quickly to solve problems when told about safety hazards.	1	2	3	4	5
Insist on thorough and regular safety audits and inspections.	1	2	3	4	5
Try to continually improve safety levels in each work area.	1	2	3	4	5
Provide all the equipment needed to do the job safely.	1	2	3	4	5
Are strict about working safely even when work falls behind schedule.	1	2	3	4	5
Quickly correct any safety hazard no matter what the cost.	1	2	3	4	5
Provide detailed safety reports to workers regarding injuries, near accidents, etc.	1	2	3	4	5
Consider a person's safety behavior when moving or promoting people.	1	2	3	4	5
Require each manager to help improve safety in his or her work area.	1	2	3	4	5
Invest a lot of time and money in safety training for workers.	1	2	3	4	5
Use any available information to improve safety rules.	1	2	3	4	5
Listen to workers' ideas on improving safety.	1	2	3	4	5
Consider safety when setting production and speed schedules.	1	2	3	4	5
Provide workers with a lot of information on safety issues.	1	2	3	4	5
Regularly hold safety awareness events (meetings, presentations, etc.)	1	2	3	4	5
Give safety personnel the power they need to do their job.	1	2	3	4	5

Group Level Safety Climate:
Please answer the following questions about your supervisor or supervisors.

My supervisor(s) …	1 = Strongly agree 2= Agree 3 = Neutral 4 = Disagree 5 = Strongly Disagree				
Makes sure we all receive the equipment needed to do the job safely.	1	2	3	4	5
Frequently checks to see if we are all obeying safety rules.	1	2	3	4	5
Discusses how to improve safety with us.	1	2	3	4	5
Uses explanations (not just forced compliance) to get us to act safely.	1	2	3	4	5
Emphasizes safety procedures when we are working under pressure.	1	2	3	4	5
Frequently tells us about the hazards in our work.	1	2	3	4	5
Refuses to ignore safety rules when work falls behind schedule.	1	2	3	4	5
Makes sure we follow all the safety rules (not just the most important ones).	1	2	3	4	5
Insists we obey safety rules when fixing equipment or machines.	1	2	3	4	5
Praises workers who pay special attention to safety.	1	2	3	4	5
Is strict about safety at the end of the day when we want to go home.	1	2	3	4	5
Spends time helping us learn to see problems before they arise.	1	2	3	4	5
Frequently talks about safety issues throughout the work week.	1	2	3	4	5
Insists we wear our protective equipment even if it is uncomfortable.	1	2	3	4	5
Is strict about working safely when we are tired or stressed.	1	2	3	4	5
Remind workers who need them to work safely.	1	2	3	4	5

Appendix C
Organization and Group Level Quality Climate
Please answer the questions below by circling the number which best matches your opinion on the quality climate in this organization. **Mark your answers in the following ways: 1 = Strongly agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly disagree.**
Organizational-Level Quality Climate
Please answer the following questions about your organization's top management team.

Top management in this organization ….	1= Strongly agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly disagree				
React quickly to solve problems when told about quality issues.	1	2	3	4	5
Insist on thorough and regular quality audits and inspections.	1	2	3	4	5
Emphasize the importance of continuous quality improvement in each work area.	1	2	3	4	5
Provide all the means needed to perform jobs in a high-quality manner.	1	2	3	4	5
Are strict about quality requirements even when work falls behind schedule.	1	2	3	4	5
Quickly correct any quality errors no matter what the cost.	1	2	3	4	5
Provide detailed quality reports regarding work tasks and performance.	1	2	3	4	5
Consider a person's attitude toward quality when moving or promoting people.	1	2	3	4	5
Require each manager to help improve quality in his or her work area.	1	2	3	4	5
Invest a lot of time and money in quality training for workers.	1	2	3	4	5
Use any available information to improve quality protocols.	1	2	3	4	5
Listen to workers' ideas on continuous quality improvement.	1	2	3	4	5
Consider quality standards when setting production and speed schedules.	1	2	3	4	5
Provide workers with continuous feedback on quality performance.	1	2	3	4	5
Regularly hold quality awareness events (meetings, presentations, updates, etc.)	1	2	3	4	5
Give quality leaders the power they need to meet quality goals.	1	2	3	4	5

Group Level Quality Climate:

Please answer the following questions about your supervisor or supervisors.

My supervisor(s) …	1= Strongly agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly disagree				
Makes sure we all receive the means and support needed to meet quality requirements.	1	2	3	4	5
Frequently checks to see if we are all complying with quality requirements.	1	2	3	4	5
Discusses ways to improve quality with us.	1	2	3	4	5
Uses explanations (not just forced compliance) to improve product quality.	1	2	3	4	5
Emphasizes quality procedures when we are working under pressure.	1	2	3	4	5
Refuses to ignore quality requirements when work falls behind schedule.	1	2	3	4	5
Makes sure we follow all the quality procedures (not just the most important ones).	1	2	3	4	5
Insists we follow quality requirements when fixing equipment or machines.	1	2	3	4	5
Praises workers who pay special attention to quality.	1	2	3	4	5
Is strict about quality at the end of the day when we want to go home.	1	2	3	4	5
Spends time helping us learn to see quality problems before they arise.	1	2	3	4	5
Frequently talks about quality issues throughout the work week.	1	2	3	4	5
Insists we follow through on quality requirements even when it's inconvenient.	1	2	3	4	5
Is strict about quality protocols when we are tired or stressed.	1	2	3	4	5
Reminds workers who need them to work with quality in mind.	1	2	3	4	5

Appendix D
Safety Decision Scenario

Procedures when Entering the Grain Bin

You and a co-worker are emptying a bin and working to fill a waiting truck. Your supervisor walks by to check on your progress and notices the flow of grain to the truck has slowed. Your supervisor suggests keeping the auger running while someone gets inside the bin to release the blockage and keep the grain flowing. You are surprised because your organization normally follows the grain safety handling standard administered by OSHA, which require lock out / tag out of the bin before entry. You need to decide what to do next. You have the following four options.

1. **Enter Bin:** Enter the grain bin to release the blockage
2. **Follow Entrance Procedure:** Follow the correct entrance procedures, taking appropriate time to resolve the flow problem safely
3. **Confront Supervisor, Follow Procedure:** Confront your supervisor, telling him you will follow the entrance safety procedures even if it will slow the work
4. **Follow Procedure and Report Supervisor:** Follow the correct procedure and then report the supervisor's instructions to management

These four factors could impact your decision:

1. Safety
2. Productivity
3. Supervisor's opinion of you
4. Peer pressure

When you are ready, follow the steps below in order to initiate and complete the simulation:
STEP 1: Click SELECT to view information that connects a decision factor to an option (decision factors are located on the left column and options on the upper row). The values at the bottom of each cell are given on a 21-point scale where:

-10 = assumes a very unfavorable evaluation of the option for that specific decision factor
  0 = assumes a neutral evaluation of the option for that specific decision factor
 10 = assumes a very favorable evaluation of the option for that specific decision factor

STEP 2: Based on the information you have looked at, choose the best option by clicking on the Final Choice button, located at the lowest cell in the column of the option you choose.

STEP 3: Confirm your choice by clicking Final Decision when prompted.

Options Decision Factors	Enter bin	Follow entrance procedure	Confront supervisor; follow procedure	Follow the procedure; report supervisor
Potential safety concerns	Agreeing to by-pass safety procedures could lead to you or your co-worker being trapped, injured, or killed -10	No potential safety concerns in this case 0	You have stated your position on following safety procedures and you will not be asked to skip safety procedures in the future +3	May help establish new safety leadership training procedures for supervisors and new policy for reporting policy violations +10
Productivity	By-passing safety procedures will allow you to fix the problem with very little or no down time +10	Following safety procedures takes more time and delays the filling of the trucks -4	Confronting the supervisor will delay work, putting the loading schedule behind -7	Following safety procedures takes more time, but may allow for the identification and prevention of conditions causing grain blockages, preventing future issues +4
Supervisor's opinion of you	Supervisor is impressed with your work efficiency and thinks you are a team player who can get things done on time +7	Supervisor is unaware of your actions. No effect on supervisor's opinion of you 0	Supervisor feels threatened and may spread the idea around the organization that you are not a team player -8	There is a slight chance your supervisor will discover you reported his behavior, but this is unlikely -2

Peer Pressure	Your co-workers are not pleased that you by-passed safety procedures because you have established a pattern of risky behavior for them to follow -6	Co-workers are pleased that you followed safety rules; makes it easier for them to justify their safety behavior +4	Co-workers are relieved that you spoke up and opposed the supervisor +4	Although they do not want to draw much attention to the work team, your co-workers appreciate you standing up to the supervisor +1

Appendix E
Quality Decision Scenario

Quality Control Procedures
Long term storage of wet corn has been a continuing problem at the grain cooperative where you work. The policy of the cooperative is that no member of the cooperative should be turned away from delivering corn – all loads are received and stored somewhere.
A member of the cooperative pulls in with a load of very wet corn. You are directed to dump the load directly on a large uncovered pile of corn on the ground near the storage bins. You do not know the moisture levels of the corn in the pile.
You must decide on the next step. The following four items are your options.
1. **Dump the Corn:** Dump the corn on the pile as directed and document your action
2. **Do not Accept Corn:** Do not accept the wet corn from the customer
3. **Dry Corn First:** Insist on drying the corn before dumping it on the pile
4. **Check Moisture Levels in Pile:** Check the moisture level on the pile before deciding where to dump corn

These four factors could impact your decision.

1. Storage risk
2. Customer service
3. Costs to company
4. Company policy

When you are ready, follow the steps below in order to initiate and complete the simulation:

STEP 1: Click SELECT to view information that connects a decision factor to an option (decision factors located on the left column and options on the upper row). The values at the bottom of each cell are given on a 21 point scale where:

-10 = assumes a very unfavorable evaluation of the option for that specific decision factor
0 = assumes a neutral evaluation of the option for that specific decision factor
+10 = assumes a very favorable evaluation of the option for that specific decision factor

STEP 2: Based on the information you have looked at, choose the best option by clicking on the Final Choice button, located at the lowest cell in the column of the option you choose.

STEP 3: Confirm your choice by clicking Final Decision when prompted.

Alternative Dimension	Dump corn	Do not accept corn	Dry corn first	Check moisture level in pile
Storage risk	Wet corn will mold easily if dumped on wet corn, causing spoilage, safety hazards, and danger of fire -10	No storage risk +10	Dry corn can be stored for a longer time, but if dumped into wet corn, still has high risk of mold and spoilage -7	If moisture level of pile is known, corn can be dumped to a location best suited for storage +7
Customer service	Customer is charged for high moisture corn, but has no problem with the level of discount +8	Customer very unsatisfied – complains to management -8	Customer is charged for drying and has no issue with discounts +4	Inconveniences customer while a decision is made about where to dump the load -3
Cost to company	No cost short term, but probable financial losses because poor storage conditions will increase spoilage and shrink of grain -6	Because no wet corn was accepted, no losses expected from spoiled or damaged corn +7	Dried corn will store better for a longer time but dumping dry corn on wet piles will not prevent long term spoilage and increases potential for financial losses +3	Measures to manage moisture take additional time and may cost more, but save money in the long run with lower levels of spoilage and damage +5
Following company policy	Followed company policy by accepting wet corn +4	This goes directly against company policy – you could be disciplined or fired because of your actions -7	Drying corn and dumping onto a pile with unknown moisture levels is not addressed in company policy, but is not recommended -3	This action would fall outside of normal operating procedures, and may not be supported by management -5