Safety Climate as an Indicator and Predictor of Safety Performance: A Case Study

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Abstract: This study compared and objectively gauged the safety climate in the manufacturing facilities (high safety performing vs. low safety performing) to identify the most impactful areas to focus to reduce or prevent workplace injuries. In order to accomplish the study objective, we employed the Nordic Safety Climate Questionnaire (NOSACQ-50) consisted of 50 items across seven dimensions. A total of 116 operations employees in the paper laminate manufacturing completed the survey. The two sites were both within the United States and had structured the same operations. The results of the comparisons showed that there was a significant difference in the total scores for the sites. The high performance site had significantly higher NOSACQ-50 scores than the underperforming site in all dimensions. The high performing site had the greater safety climate scores in the area of "management safety priority & ability". The underperforming site recorded comparatively lower scores in the areas of "management safety empowerment", "group safety priority", and "worker safety commitment". We provided the recommendations of three focus areas: commitment, involvement, and accountability. The outcomes from this study could be useful to apply resources and focus to the appropriate areas in order to make safety improvements. In turn, improving safety climate can have positive impacts on increasing employee safety while improving the viability of the organization.

Key words: Safety climate, Perceptions, Nordic Safety Climate Questionnaire, Occupational injury, Safety performance

1. Introduction

In accordance to the National Census of Fatal Occupational Injuries in 2015 conducted by the Bureau of Labor Statistics (BLS), a total of 4,836 fatal work injuries were recorded in the United States in 2015, the highest annual figure since 2008 (BLS, 2017a). Also, serious and nonfatal workplace injuries amounted to nearly $60 billion in direct U.S. workers' compensation costs, translating into more than a billion dollars a week spent by businesses on these injuries (Liberty Mutual Workplace Safety Index, 2017). Several different types of management practices are in place and being used to prevent injuries from taking place in the workplace. However, it is unclear on what management practice components are the most effective in overall safety programs. Many different factors are built into a safety program and the overall performance is dependent on employee contribution and upper management commitment. A strong organizational culture is one where espoused values are consistent with behavior and where employees share the same view of the firm. On the other hand, a weak culture results when people at all levels of the hierarchy fail to share the values adopted by management (Vredenburgh, 2002).

Safety culture and safety climate do differ so a distinction should be made. The difference between culture and climate is an important concept to understand but not to overcomplicate. Safety culture is a shared set of safety-related attitudes, behaviors, values, and ingrained assumptions that orient organizational action pertaining to safety (Petitta et al., 2017). Simply understanding that safety culture is driven from the top level (CEO, directors, etc.) to the shop floor (machine operators, maintenance employees, etc.) is an appropriate place to start. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures (Ali et al., 2009).

Safety climate is the shared perceptions among the members of a social unit, of policies, procedures and practices related to safety in the organization (Neal & Griffin, 2002; Beus et al., 2010). In short, safety climate reflects workers' perception of the true value of safety in an organization - as a contributing factor towards the reduction of accidental injuries. Management values, organizational practices, communication, and employee involvement are important contributors for developing the perception (Neal et al., 2000). The company's leadership may say that safety is an important factor in all decision-making and in all operations. However, do the employees working for the company feel this way? A well-written mission statement and management principles mean nothing if the employees do not feel well-cared for. It is believed that a strong correlation may be seen between the underperforming site's safety climate score (low score) and

many behaviorally rooted injuries. Conversely, the high performing site may have a better safety climate score. A great example of this type of questionnaire to be used was the Nordic Safety Climate Questionnaire (NOSACQ-50). This NOSACQ questionnaire consisted of 50 items in seven dimensions and was valid for predicting perceived safety level and self-rated safety behavior. Additionally, the NOSACQ-50 supported comparative studies of safety climate between and within companies (with a similar structure, and/or similar health & safety management systems), industries, and countries and was suitable for research purposes as well as for practical use in evaluating safety climate status, as a diagnostic tool and in evaluating the effect of safety climate interventions (Kines et al., 2011). The NOSACQ-50 is of the Nordic region but studies found that this method is reliable and effective far beyond that region (Kines et al., 2011; Yousefi et al., 2016).

In this context, using a self-administered Nordic Safety Climate Questionnaire (NOSACQ-50), we compared the similar structured sites (high performing vs low performing) to identify the most impactful areas to focus in order to reduce or prevent workplace injuries. The outcome from this study is the intent to apply resources and focus to the appropriate areas in order to make safety improvements at the site. This study may reveal the least amount of resources in the most efficient manner in order to garner the most about of safety performance improvement.

2. Methods

2.1 Participants and Scope

Thirty-three employees from the Dixon, Illinois location ("Site A" – High performing/low injuries site) and eighty-three operators from the Mills River, North Carolina location ("Site B" – Low performing/high injuries site) in the paper laminate manufacturing participated in the study. The two sites were both within the United States and had structured the same operations (lay-out, plant structure, shift patterns). The participants involved in the survey accounted for roughly half of all of the shop floor employees at the locations. Members of the local operations management teams were not in part of the study. General operations employees included coating machine operators and slitting machine operators. The coating machine operators created pressure-sensitive label stock in the form of two-meter rolls. The slitting machine operators were in charge of slitting material to customer order size and lengths. The two sites were built within eight years of each other [Site A (2008) vs. Site B (2000)]. The Site A (Dixon, IL) was a top performer in safety within the organization based on the total incidence frequency rate. The calculation for total incidence frequency rate is: number of medical treatment cases * 200,000) / working hours of the site. In 2016 the incident rate for the Site A (Dixon, IL) was 0.97 using the total incidence frequency calculation previously mentioned. The Site B (Mills River, NC) had an incidence rate of 4.32 using the same calculation. Note that the Site B recorded a higher incident rate compared to the industry (paper product manufacturing) average of 3.1 recordable cases (BLS, 2017b). The Site B had many recordable injuries, yet the process was the same as the Site A (i.e., high performing/low injury site). At both locations, adhesive was applied to paper and slit down to the appropriate size for the customer's needs. There was no significant variation in the process that leads to additional risk. Production of labelstock material for the units is quite similar relative to their staffing. The physical operations being the same and the output being relatively the same further proves a comparison between the sites to be appropriate.

2.2 Questionnaire

In an effort to accurately and objectively gauge the safety climate in the facilities, the authors employed the use of the Nordic Safety Climate Questionnaire (NOSACQ-50) (Kines et al., 2011). The NOSACQ-50 consisted of 50 items across seven dimensions, i.e., shared perceptions of:

- Dimension 1 (Questions 1-9) - Management safety priority and ability;
- Dimension 2 (Questions 10-16) - Management safety empowerment;
- Dimension 3 (Questions 17-22) - Management safety justice
- Dimension 4 (Questions 23-28) - Worker safety commitment;
- Dimension 5 (Questions 29-35) - Worker safety priority and risk non-acceptance;
- Dimension 6 (Questions 36-43) - Peer safety communication, learning, and trust in safety ability; and
- Dimension 7 (Questions 44-50) - Worker trust in the efficacy of safety systems.

Each question had a Likert scale for response (multiple choice answers). The choices for all questions were: strongly disagree, disagree, agree, and strongly agree.

2.3 Conducting the survey

Surveys of the Dixon (Site A) and Mills River (Site B) were conducted over the course of 6 months. The survey was recreated in Survey Monkey with all of the original wording. Each employee was encouraged to complete the survey in an honest and objective fashion. Reassurance was given as to the anonymity of the survey. All employees were given unlimited time away from their work area to complete the survey. All of the employees took the Nordic Safety Climate Questionnaire alone and without the influence of other employees.

2.4 Statistical data analysis

The data from the survey was collected in the Survey Monkey tool. The Survey Monkey tool allows for exporting all collected data. Statistical analysis for descriptive statistics and t-tests of the data were conducted using SAS® (Statistical Analysis Software) 9.3 Software. SAS® is an analytics software suite developed by SAS Institute Inc., Cary, NC, USA. The negatively worded questions were reverse scored to meet the requirements of the Nordic Safety Climate Questionnaire guidance. An example of a positively worded question versus a negatively worded question follows. A positively worded question, NOSACQ-50 question 4: management places safety before production. The top score for this question is a 4 which equals a "strongly agree" response. A negatively worded question, NOSACQ-50 question 3: management looks the other way when someone is carless with safety. A top score on this response would be a 1 which equals a "strongly disagree" response. In order to properly organize and calculate results all negatively worded questions were reversed scored, meaning a response that equals a value of 1 equals a 4. In total there were 21 negatively worded questions and 29 positively worded questions. Based on this organization of data, the mean value for each person was able to be determined for each dimension within the survey.

3. Results

A total of 116 operations employees (33 from the Dixon, Illinois location (i.e., Site A - High performance site); 83 from the Mills River, North Carolina location (Site B - Low performing site)) completed the survey. Table 1 presents the department and experience of the participating operations employees for each of the locations. About two-thirds of the operators work in finishing departments, and the others work in coating departments (21.1%) and mill service departments (10.5%). About one-third of the participants have over nine years of experience in their current position, while almost 40% of the operators have under three years of experience. Almost a half of the employees have worked for the company more than nine years, while about one-third of the workers have worked fewer than three years. Site B had relatively more operations employees in finishing, and less in mill services than Site A. There were more inexperienced workers with less than one year of experience at Site B than Site A. Also, Site B had more employees with over nine years of experience in their current position, and more workers with over nine years at that company, than did Site A.

Table 1. Frequencies of department and experience of participating operations employees by location.

		Location		Total (n=116)
		Site A† (n=33)	Site B‡ (n=83)	
Department	Finishing	19 (57.6%)	59 (72.8%)	78 (68.4%)
	Coating	11 (33.3%)	13 (16.1%)	24 (21.1%)
	Mill services	3 (9.1%)	9 (11.1%)	12 (10.5%)
Experience in Current Position	Less than 1 Year	3 (9.4%)	20 (24.1%)	23 (20.0%)
	1-3 Years	7 (21.9%)	16 (19.3%)	23 (20.0%)
	3-5 Years	11(34.4%)	6 (7.2%)	17 (14.8%)
	5-7 Years	3 (9.4%)	4 (4.8%)	7 (6.1%)
	7-9 Years	1 (3.1%)	4 (4.8%)	5 (4.4%)
	More than 9 Years	7 (21.9%)	33 (39.8%)	40 (34.8%)
Years Worked the Company	Less than 1 Year	3 (9.1%)	20 (24.1%)	23 (19.8%)
	1-3 Years	5 (15.2%)	9 (10.8%)	14 (12.1%)
	3-5 Years	7 (21.2%)	4 (4.8%)	11 (9.5%)
	5-7 Years	7 (21.2%)	3 (3.6%)	10 (8.6%)
	7-9 Years	2 (6.1%)	1 (1.2%)	3 (2.6%)
	More than 9 Years	9 (27.3%)	46 (55.4%)	55 (47.4%)

Note: †Site A – High performance site. ‡Site B – Low performance site.

Table 2 shows the independent-samples t-tests for each dimension score, as well as the total. An independent-samples t-test was conducted to compare the NOSACQ-50 scores at Site A and those at Site B. There was a significant difference in the total scores for Site A (Mean = 3.5219, SD = 0.4539) and Site B (Mean = 3.0824, SD = 0.4230; t(114) = 4.94, p <0.0001). Also, Site A had significantly higher NOSACQ-50 scores than Site B in all seven dimensions respectively (p<0.0001).

Table 2. Independent-samples t-tests for each dimension scores and the total score.

NOSACQ-50 Score	Location	*N*	Mean	Standard	Degree of	*t* value	*p* value
Dimension 1	Site A†	33	3.6411	0.4785	114	5.14	<0.0001
	Site B‡	88	3.1138	0.5059			
Dimension 2	Site A†	33	3.5177	0.5297	114	4.24	<0.0001
	Site B‡	83	3.0327	0.5654			
Dimension 3	Site A†	33	3.3788	0.6071	114	3.36	0.0011
	Site B‡	83	3.0161	0.4895			
Dimension 4	Site A†	33	3.5182	0.4499	114	4.81	<0.0001
	Site B‡	83	3.0743	0.4475			
Dimension 5	Site A†	33	3.5000	0.5297	114	4.66	<0.0001
	Site B‡	83	3.0232	0.4842			
Dimension 6	Site A†	33	3.5399	0.4768	114	4.44	<0.0001
	Site B‡	83	3.1244	0.4458			
Dimension 7	Site A†	33	3.5043	0.4939	114	3.58	0.0005
	Site B‡	83	3.1701	0.4378			
Total	Site A†	33	3.5219	0.4539	114	4.94	<0.0001
	Site B‡	83	3.0824	0.4230			

NOTE: †Site A – High performance site. ‡Site B – Low performance site.

Dimension 1 (Management safety priority and ability); Dimension 2 (Management safety empowerment); Dimension 3 (Management safety justice); Dimension 4 (Worker safety commitment); Dimension 5 (Worker safety priority and risk non-acceptance); Dimension 6 (Peer safety communication, learning, and trust in safety ability); Dimension 7 (Worker trust in the efficacy of safety systems)

Figure 1 depicts the differences in the sites' scores across all seven dimensions of the survey. The error bars represent incidents rates ± 1 standard deviations. Relatively lower scores were reported at Site B in Dimension 2 (Management safety empowerment); Dimension 3 (Management safety justice); and Dimension 5 (Worker safety priority and risk non-acceptance).

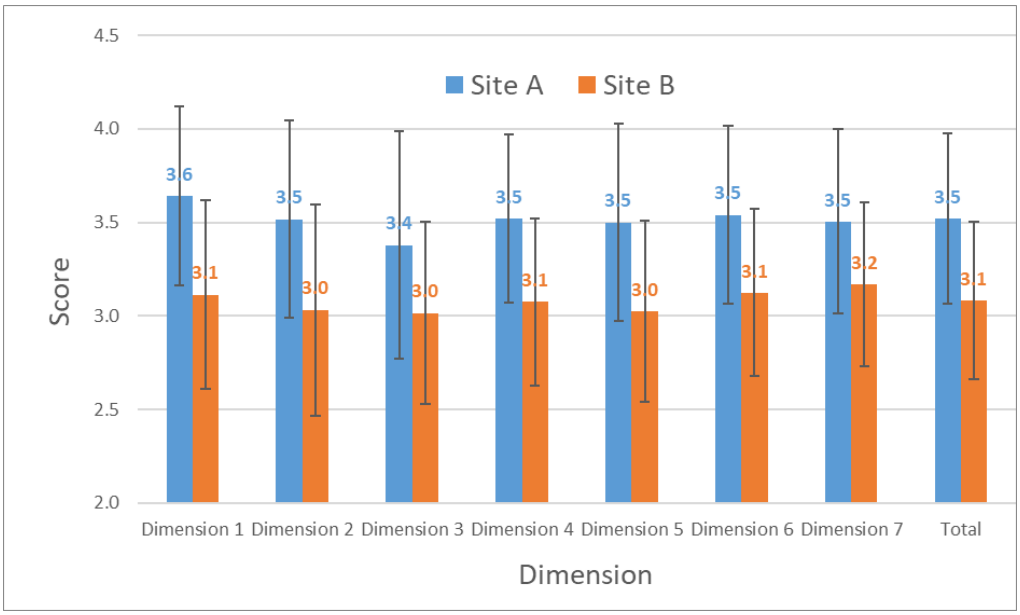

Figure 1. Differences in the NOSACQ-50 scores between Site A (High performance) and Site B (Low performance)

NOTE: Dimension 1 (Management safety priority and ability); Dimension 2 (Management safety empowerment); Dimension 3 (Management safety justice); Dimension 4 (Worker safety commitment); Dimension 5 (Worker safety priority and risk non-acceptance); Dimension 6 (Peer safety communication, learning, and trust in safety ability); Dimension 7 (Worker trust in the efficacy of safety systems)

When compared, as shown in Figure 2, Site A reported the higher NOSACQ-50 scores in Dimension 1 (management safety priority), Dimension 2 (management safety empowerment), Dimension 4 (worker safety commitment), and Dimension 5 (group safety priority - worker safety priority and risk non-acceptance).

Figure 2. NOSACQ-50 Safety climate dimensions (scale 1-4)

The guidance from the Nordic Safety Climate Questionnaire titled "Interpreting the Nordic Occupational Safety Climate Questionnaire NOSACQ-50 Results" states that the following areas are related to scores: below 2.70 (a low level with great need of improvement), 2.70 – 2.99 (calculative - a fairly low level with need of improvement); 3.00 – 3.30 (proactive - a fairly good level with slight need of improvement); Greater than 3.30 (generative - a good level allowing for maintaining and continuing developments) (National Research Centre for the Working Environment, 2017). At Site A, 96% of the average scores for the 50 questions from the questionnaire were greater than 3.30 [generative – a good level allowing for maintaining and continuing developments], and only the averages for Question 20 *(Management looks for causes, not guilty persons, when an accident occurs)* and Question 29 *(We who work here regard risks as unavoidable)* were between 3.00 – 3.30 [proactive – a fairly good level with slight need of improvement]. In contrast, at Site B, only one average score for question 3 (in Dimension 1) *(Management looks the other way when someone is careless with safety)* was above the score of 3.30. Twenty-four percent of the average scores were between 2.70 - 2.99 (calculative), and seventy-four percent were 3.00 – 3.30 (proactive). Figure 3 shows the percentages of score categories for each dimension of the 50 questions at Site B (low performing site). Relatively higher percentages of "calculative–a fairly low level with need of improvement" were reported in Dimension 2 (Management safety empowerment); Dimension 3 (Management safety justice); Dimension 4 (Worker safety commitment); and Dimension 5 (Worker safety priority and risk non-acceptance).

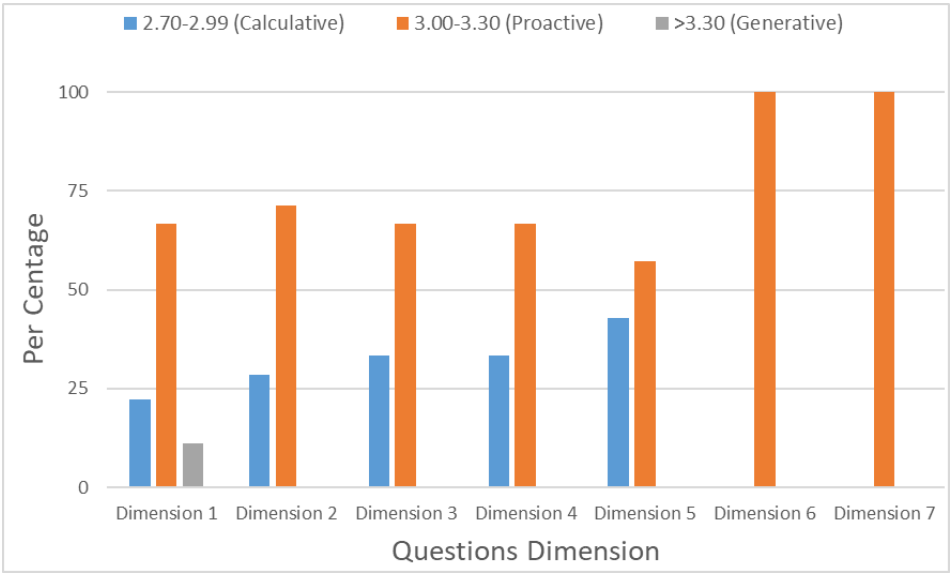

Figure 3. Percentages of score categories for each dimension of the 50 questions (Site B)

NOTE: Dimension 1 (Management safety priority and ability); Dimension 2 (Management safety empowerment); Dimension 3 (Management safety justice); Dimension 4 (Worker safety commitment); Dimension 5 (Worker safety priority and risk non-acceptance); Dimension 6 (Peer safety communication, learning, and trust in safety ability); Dimension 7 (Worker trust in the efficacy of safety systems)

4. Discussion

This survey study was intended to identify the safety climate differences between the two similar structured sites (Site A: high performing VS. Site B: low performing) using the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50). These results suggest that the site affected the NOSACQ-50 scores. Site A had higher total NOSACQ-50 scores than Site B. Similarly, there were considerable differences in the scores of Site A and Site B across all seven dimensions. The findings from this study concurred that the low performing site had the lower safety climate score and the high performing site had the greater safety climate score. The high performing site reported the greater safety climate scores in the areas of management safety priority and ability, management safety empowerment, worker safety commitment, and peer safety communication, learning, and trust in safety ability. Whereas, the underperforming site recorded relatively lower scores in the areas of management safety empowerment, management safety justice, worker safety commitment, and worker safety priority and risk non-acceptance. Moreover, the greater differences between Site A and Site B (the difference between average scores of Site A and Site B in each dimension) were in the areas of management safety priority, management safety empowerment, group safety priority (worker safety priority and risk non-acceptance), and worker safety commitment.

Management safety priority refers to perceptions of management behavior; to actions that clearly demonstrate that they give priority to safety, even in times of production pressure; they are knowledgeable about safety and also actively support safety initiatives from the respondents. Management safety justice refers to an open and fair reporting culture, wherein accidents and near-misses' can openly be discussed and analyzed, and there is no fear of blame. Safety empowerment addresses management actions that actively include the respondents in decisions regarding safety and to support safety initiatives from the respondents. Similarly, according to Safe Work Australia (2017), two important aspects of safety climate are management safety empowerment and management safety justice, which are the perceived degree to which employers respectively empower their workers to influence aspects of their own safety and deal with health and safety incidents fairly and justly.

In this study, the turnover rate for the higher safety climate facility was 5%. The rate of the underperforming facility was 13%, nearly three times greater than that of the high performing site. While 9% of the higher safety climate site's employees had less than one year of service, 14% of the underperforming site's employees had less than one year of service. The new employees coming to the underperforming site were more likely to leave rather quickly, where many workers were employed on a temporary basis. Typically, the temporary workers were newer to the workforce and relatively inexperienced in manufacturing. Temporary workers, also called contingent workers, often suffer from inadequate training and an unwillingness to speak up regarding safety issues (Breslin et al., 2007). A higher turnover rate presents unique challenges for the safety climate that is on the shop floor. The underperforming site was certainly at a disadvantage due to the higher turnover rate and amount of employees with less than one year of service. Employee retention is an important issue. The greater and faster gains were achieved more quickly with a higher level of mean tenure (Beus et al., 2010). This is a critical aspect for companies to keep in mind as the average tenure levels dip and the turnover rate climbs.

Based on the reviewing the current study and the literature, we provided the recommendations of three focus areas: commitment, involvement, and accountability.

Commitment is likely the most crucial part of improving site safety climate and promoting the desired culture. Organizational safety commitment is the extent of engagement with safety promotion and accident prevention in an organization. Factors include strong belief and acceptance of the organization's goals and values, willingness to exert considerable effort on behalf of the organization, and a strong desire to maintain membership in the organization. A common characteristic of all the companies was the high safety commitment of their managers and workers, which often were embedded in the companies' business strategies. It is very likely that this commitment is the main driver for long-term safety improvements (Zwetsloot et al., 2017). Safety climate needs to be assessed by site management as it will help the leaders to understand the relation between individual and group perceptions. A strong relationship proving supervisors are of vital importance (Yule et al., 2006). Supervisors are the voice of the manager and will help enact policies and the vision the manager desires. The degree at which the message and commitment are communicated is up to the individual supervisor. It is important the messages are sound, deliberate, and unambiguous. This will help the supervisor carry out the necessary message while promoting the manager's commitment. Commitment through supervisor empowerment will contribute a great deal to improving the overall safety climate. The increased workload on managers may negatively impact safety climate (Carroll, 1998). Managers may not fully understand workload resources and may dismiss low morale as not truly safety related. This couples with the decision making at locations being done at a high level and the supervisors are then held to carry out the orders. Oftentimes the perception is that decisions are made too hierarchical without appropriate feedback to the manager. Having latitude with and input from supervisors will contribute to the commitment while helping to improve safety climate. Demonstration of commitment can have a real impact. Employee safety perception related to the management's commitment had a significant influence to the lost time accident rate (O'Toole, 2002).

In terms of involvement (empowerment), the interaction and effectiveness of supervisors is key when discussing involvement. Supervisors are the key link between department management and the shop floor employees. The supervisors will convey the message they are given. A positive and knowledgeable approach of supervisors is found to be helpful in predicting the knowledge and training that occurs with their direct reports. A positive working relationship from the shop floor to the supervisor will also show respect for improvement ideas. This will include actively listening to complaints and helping to achieve successful implementation of ideas. The increased involvement will aid in empowering the workers[16]. Empowering employees is incredibly effective to get buy-in. Empowering workers provides them with authority, responsibility, and accountability for required decisions and ensures that both employees and management are involved in setting goals and objectives (Vredenburgh, 2002). The involvement could lead to better outcomes for any task or project that is on-going. This may help to develop better and more in-depth risk assessments or standard operating procedures. In order to influence safety practices, feedback must be provided to the employees who are capable of using it. It needs to be given to those working at the point in the process where their behavior can effectively influence outcomes. People cannot behave in a safety-conscious manner unless they have the authority to change their own actions to improve their work conditions (Vredenburgh, 2002). Involvement and the ability to make changes will be beneficial in getting the most out of each development area. The possibilities with effective involvement are endless. Tapping into each resource in a location is something that any site can find benefit in. Showing interest and appreciation for employees' involvement will help the site to find accountability and commitment within their safety program.

Regarding accountability, the senior management can be ambiguous and abrasive, which creates fear while they should be reinforcing positive behaviors as a form of training (Carroll, 1998). Promotion of accountability but withholding

inappropriate consequence is the best approach (Carroll, 1998). Individuals in an organization will test the boundaries of any program; be it quality, safety, or any other program. Procedures, methods, and guidelines will be tested at some point. It is important the company is prepared to respond to these situations. As with any policy, the effort to develop a strong safety culture is unlikely to be effective if the organization is not reinforcing the desired behaviors (or is rewarding inconsistent behaviors such as speed or production rates (Vredenburgh, 2002). Minimizing the impact of these moments is key. A strong safety climate and safety culture will be helpful in limiting these impacts. A strong safety climate will be helpful to keep rogue acts from happening. As previously mentioned individuals will assimilate to the climate they are placed in. People are motivated to behave in ways that lead to desired consequences; they will modify their behavior to conform to a cultural norm if it is perceived that compliance will lead to a desirable outcome. Culture is learned through a connection that is made between behaviors and consequences (Vredenburgh, 2002). If the climate is already weak, the individual will likely continue with the unsafe acts or not follow standard operating procedures. An excellent way to cover many bases is to invest in employee training. At the most, basic definition training will create knowledge and consistency of that knowledge throughout the workforce. The training will help employees to identify and handle risks (Vredenburgh, 2002; Yule et al., 2006). Accountability is most influenced by knowledge and training, even to a greater extent than personal responsibility (Yule et al., 2006). To add to this, the same study found that not investing in proper training for employees may increase risk-taking and sends a message that managers are not interested or committed to their employees. Accountability and discipline are crucial to high functioning programs and need to be redefined. Accountability can be used to establish a commitment by uniformly enforcing rules and procedures. Discipline can also protect and encourage leaders by ensuring rules are enforced appropriately. Accountability in all forms should be used to correctly steer the safety climate towards the established objectives. The feedback portion, positive or negative, is critical in keeping on the correct path. For an organization to excel, all individuals must be accountable to the safety systems and procedures that are in place (Hajaistron, 2014).

5. Conclusions

This survey study was to assess the organizational safety climate of the similar structured sites (high performance vs. low performance) using the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50). The findings form this study revealed that there were substantial differences in the safety climate scores across all dimensions in the sites. Specifically, the high performing site had the greater safety climate scores in the area of “management safety priority”. The underperforming site recorded comparatively lower scores in the areas of “management safety empowerment”, “group safety priority (worker safety priority and risk non-acceptance)”, and “worker safety commitment”. The outcomes from this study could be useful to apply resources and focus to the appropriate areas in order to make safety improvements at the site. In addition, there is always a business side to the improvements as well. It is well known that lower injury rates cost companies less money in terms of loss productivity and bottom line costs. We believe that improving safety climate focusing on commitment, involvement and accountability can have a substantial impact on increasing employee safety and lowering the incidence frequency rate while improving the viability of the organization.

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