Analysis of the safety performance measurement system at Company XYZ.

by

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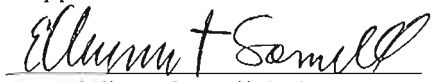
A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
in

Risk Control

Approved: 2 Semester Credits



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March, 2010

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Title: ***Analysis of the safety performance measurement system at Company XYZ***

Graduate Degree/ Major: MS Risk Control

Research Adviser: **Elbert Sorrell, Ed.D.**

Month/Year: **March, 2010**

Number of Pages: **58**

Style Manual Used: **American Psychological Association, 6th edition**

Abstract

The purpose of this study was to describe how Company XYZ can implement current and leading indicators to measure their safety performance. Currently, a number of organizations focus on incident rates and other lagging indicators to measure safety system performance. Lagging indicators are unreliable and ineffective benchmarks to exclusively measure safety system improvement. By employing a performance measurement system utilizing leading and current indicators, an organization would more effectively and efficiently address issues within their safety system. The goals of this study were threefold: identify and evaluate the current process used to measure safety performance at Company XYZ, demonstrate the applicability of using various statistical process control tools to measure safety system performance, and to develop a process that would produce data that could be used to determine safety system performance.

Quantitative and qualitative methods were utilized to accomplish the goals of this study. Methods employed include a semi-structured interview to identify and evaluate current viewpoints of safety system at Company XYZ, quantitative analysis of safety system data to demonstrate the applicability of using statistical process control tools to measure safety system performance, and a review of literature to develop a process that would proactively determine safety system performance.

Information collected through the semi-structured interview and quantitative analysis of data suggests that the current system at Company XYZ would benefit from a safety performance measurement system that utilizes current and leading indicators. Current viewpoints suggest various opportunities for improvement include increasing accountability and employee involvement, as well as, treating safety the same as productivity and quality. Eighty-two percent of injuries at illnesses experienced at Company XYZ include overexertion, struck by and against, and slips and falls. Reducing the frequency and severity of these incidents will positively affect lost workdays and associated workers' compensation costs. Finally, a formal safety management system should be implemented with the elements serving as the standards of performance measurement.

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Acknowledgments

I would like to express my gratitude to the Risk Control Department at the University of Wisconsin-Stout for providing invaluable knowledge and abilities. I would like to thank my research advisor, Dr. Elbert Sorrell, for the guidance provided during this process. I am also grateful for the love and support that my family and friends have provided throughout my educational career.

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Chapter I: Introduction

Performance measurement can be defined as the "ongoing monitoring and reporting of program accomplishments, particularly progress towards preestablished goals" (United States General Accounting Office, 1998, p. 3). Within this process, typically performed by management, the efficacy of inputs, outputs, and consequences are evaluated against organizational goals and standards. Within Managing for Performance Perfection: The Changing Emphasis, Pope (1990, p. 4) stated, "industrial excellence is the product of quality in management". Performance measurement provides information on the current status of the organization, as well as, opportunities for improvement. To be successful management must be concerned with the improvement of processes to attain goals while eliminating inefficiencies (Pope, 1990). Performance measurement is of particular importance regarding management of quality, productivity, and safety.

One approach to measure safety performance is systems safety management. "Systems safety management is the science of continual measurement and appraisal of management oversights, diagnosed as operational mishaps, having an adverse effect upon the best utilization of human, human, material, and economic resources" (Pope, 1990, p. 4). By utilizing systems safety management the associated risks may be identified and therefore controlled. There are various systems that could aid in this process and they include OSHAS 18001, OSHA VPP, and the ISMEC Model. Pope (1990) further stated that safety is an indication of organizational health. Safety performance is a critical aspect to the success of an organization. With positive performance of the safety system associated losses are minimized, including occupational injuries and illnesses, property damage, and associated costs. A successful management system reduces the severity and probability of losses within the organization.

There are various processes to evaluate safety performance. Typically these metrics utilize lagging, current, or leading indicators. A lagging indicator is a reactive measure that occurs after a form of loss, such as, inspection results, extent of physical damage, and incident rates. Conversely a leading indicator is an activity measurement benchmarked before a loss occurs. Examples of leading indicators include number of completion of safety audits, percentage of planned risk assessments completed, and number of safety committee meetings conducted. Current indicators are measurements that establish what is occurring in the system at the present time (Grabowski, Ayyalasomayajula, Merrick, & McCafferty, 2007). Current indicators may include performing job safety analyses, interviews, or surveys; there are various advantages with the variety of forms of performance measurement.

Within the safety performance measurement, lagging indicators are predominately utilized. These indicators are tangible outcomes, or consequences, that are easily measureable. Some example lagging indicators related to safety include the various Occupational Safety and Health Administration (OSHA) incident rates, Workers' Compensation claims, and insurance experience modifiers. There are various issues in relation to lagging indicators. One issue is that by definition they are indictors after a loss. Losses are symptoms of errors in management system and are not true causes of the occurrence. As Bird and Germain (1985, p. 32) stated in *Practical Loss Control Leadership,* "80% of the mistakes people make involve things that only *management* can do something about. Lagging indicators, such as incident rates, may reflect random fluctuations within the workplace (Dial, 1992). These fluctuations may be related to the likelihood of events occurring, or individuals reporting more incidents. To effectively reduce and prevent the probability of a similar event, true causes must be found. All too often safety performance measurement focuses on lagging indicators, and therefore the focus is directed to

adverse consequences of a defective process. By focusing on management of the system, eighty percent of incidents could potentially be avoided (Bird and Germain, 1985).

There are benefits to incorporating other safety performance measurements along with lagging indicators. These include current and leading indicators, both measures are evaluated before a loss occurs. These measurements focus on the inputs into the system; with quality inputs, quality outputs and consequences result. Other examples of various current and leading indicators include percentage of compliance to organizational standards and guidelines, completion of trainings and audits, and housekeeping practices. When all of these indicators are utilized they help identify deficits in the system which can thereby be addressed and in result prevent losses from occurring and reducing their associated costs. The monetary and resource savings then can be used for other process improvement contributing to industrial excellence.

Statement of the Problem

Focusing on incident rates and other lagging indicators are unreliable and ineffective benchmarks for safety system improvement. Proactively measuring safety performance is more effective for safety system improvement. By utilizing a performance measurement system utilizing leading and current indicators, an organization would more effectively and efficiently address issues within their safety system.

Purpose of the Study

This study sought to describe how Company XYZ can implement current and leading indicators to measure their safety performance.

Goals of the Study

1. Identify and evaluate the current process used to measure safety performance at Company XYZ.

2. Demonstrate the applicability of using various statistical process control tools to measure safety system performance.

3. Develop a process that would produce data that could be used to determine safety system performance.

Assumptions of the Study

- Company XYZ's safety metrics and worker's compensation cost information provided was accurate.

Limitations of the Study

There are potential weaknesses in relation in the study, they include:

- Company XYZ's safety management system may be affected by temporal changes with management and safety culture.
- Analysis of the data was based upon what Company XYZ provided to the researcher.
- Recommendations may not be able to be implemented due to cultural and management issues.

Definition of Terms

Lower Control Limit (LCL). Within a statistical process control (SPC) chart, a measurement point below the centerline that indicates a minimum value boundary.

Near hit. An accidental incident or injury that is narrowly avoided

Occupational illness. A disease or ailment that occurs from the result of a work or occupational activity.

Occupational injury. An injury that occurs from the result of a work or occupational activity.

Safety. The condition of being free of exposures to loss and risk

Upper Control Limit (UCL). Within a SPC chart, a measurement point above the centerline that indicates a maximum value boundary.

Chapter II: Literature Review

Performance Measurement

As stated earlier performance measurement is defined as "ongoing monitoring and reporting of program accomplishments, particularly progress towards preestablished goals" (United States General Accounting Office, 1998). Simply put performance measurement is the measurement of inputs, outputs, and consequences in regards to organizational goals and objectives. This process is a useful tool; it differentiates the effectiveness and efficiencies of various aspects within the organization. Performance measurement is a continual process, as new information comes to light and processes are either commended or corrected. The process of performance measurement is important due to the management axiom of "what gets measured gets done". Through measurement, individuals and systems are held accountable. If an individual or part of a system is found to be inefficient or ineffective, it is corrected or replaced. By continually evolving, attaining the goals, and improving or eliminating inadequacies, the organizational system as a whole will improve, thereby positively affecting organizational system consequences, or outcomes.

There are various issues in performance measurement. First of all, through performance measurement continual change is implemented into the organization. With change, comes resistance. It is easier to champion change than it is to implement it into an organization (Eccles, 1991). By involving everybody in the performance measurement process and providing opportunities for individuals to contribute their ideas for process improvement, the resistance to change may be overcome. Secondly, implementing change can be a monumental task. There are no simple strategies to implement change (Eccles, 1991). As companies grow larger and managers are further from the line process, management becomes more dependent on data

collection (Hayes, Wheelwright, & Clark, 1988). As the organization and performance measurement system matures, new technology is developed, new system improvements are implemented for reporting; this fosters increasingly more difficult data collection methods (Hayes, Wheelwright, & Clark, 1988). To overcome issues with new developments and technologies, innovations to the process should be implemented into established processes. Through this, it improves efficiency and reduces inherent resistance to change. Lastly, another drawback to performance measurement is that individuals or processes may undermine the performance measurement system. An example is when a manager chooses to misrepresent poor performance (Meyer, 2002). By continually implementing change and updating metrics as they mature, this challenge may be surmounted.

There are various types of performance measurement. In the past companies focused on earnings per share, however, customer satisfaction, cash flow, manufacturing effectiveness, and innovation are taken now into higher consideration (Eccles, 1991). Nonfinancial and financial measurements portray the organizations full performance (Meyer, 2002). The ultimate goal of any organization is to remain in operation. By adequately identifying, measuring and controlling all of the various aspects of the organization, they may continual improve and continue functioning.

In *Program evaluation and performance measurement: An introduction to practice*, McDavid and Hawthron provide an outline for developing and implementing a performance measurement system. Table 1 describes these steps in detail, on page 7. One form of performance measurement is benchmarking. Benchmarking consists of identifying companies that have best practices similar to what the organization is interested in comparing. External benchmarking provides organizations with best practices for any measure of interest, financial or

Table 1
*Example framework for a performance measurement system**

Table 9.1 Key Steps in Designing and Implementing a Performance Measurement System

1. Identify the organizational champions of change.
2. Understand what a performance measurement system can and cannot do, and why it is needed.
3. Establish multi-channel ways of communicating that facilitate top down, bottom up, and horizontal sharing of information, problem identification, and problem solving.
4. Clarify the expectations for the uses of the performance information that will be created.
5. Identify the resources available for developing, implementing, maintaining, and renewing the performance measurement system.
6. Take the time to understand the organizational history around similar initiatives.
7. Develop logic models for the programs or lines of business for which performance measures are being developed.
8. Identify additional constructs that are intended to represent performance for aggregation of programs or the whole organization.
9. Involve prospective users in reviewing the logic models and constructs in the proposed performance measurement system.
10. Measure the key constructs in the performance measurement system.
11. Record, analyze, interpret and report the performance data.
12. Regularly review feedback from users and, if needed, make changes to the performance measurement system.

Note. *from *Program evaluation and performance measurement: An introduction to practice* by J.C McDavid and R.L. Hawthron, 2006

nonfinancial, but is particularly effective for nonfinancial metrics (Eccles, 1991). One drawback to this measure is that there are various nuances in each organization allowing for certain processes and systems to be effective or fail. In order to gain benefit from this measure, the adopting organization must develop and evolve the information so it may be integrated into their organization. Another form is the balanced score card approach. This metric measures financial and nonfinancial dimensions (Meyer, 2002). There is numerous literature and implementations of this measure. Essentially an organization determines goals, measures, and then provides commendations for improvement, and correction for underperformance. For the balanced scorecard to be effective, the organization must find right measures (Meyer, 2002). In

this performance measurement tool dissimilar aspects may be measured; when combining dissimilar measures by formulas, may lead to distortion of results by underreporting of issues of poor performance (Meyer, 2002). This approach may be costly, has a fair degree of uncertainty, and may weaken organizational motivation; however this tool is beneficial for measuring progress towards goals and objectives (Meyer, 2002).

Safety Performance Measurement

To effectively control an issue, one must adequately define the problem. There are various ways to define safety, thereby resulting in difficulties in defining issues in safety performance measurement. Often times, safety is defined as the state of being safe, absence of risk, or being free from hazards and harm. The term 'safety' is ambiguous and often hard to describe, such as other concepts, including love, hate, and beauty; they lack one true definition. (Pope, 1990). Through the ambiguity of defining 'safety', the term means different things to different individuals. This results in issues in safety performance measurement. As Pope (1990 p.105) stated, "by the inability to define the problem, one cannot manage what one cannot measure. Without measurement, the safety function, as a control for managerial excellence, cannot exist". Another issue is that the term 'safety' is often viewed by management often views it as a righteous activity to protect the employee (Pope, 1990). This viewpoint lends safety to be seen as an aspect outside of the normal system function. When individuals are held accountable, they pay attention to their actions. Pope (1990), argues, "error-free performance is preferable to 'safety' to serve its functional intent and is much better understood by all concerned." When 'safety' is viewed as error-free performance, everybody in the organization is accountable for their performance; by implementing a safety performance system inadequacies and capabilities may be identified, controlled and improved upon.

In *Analyzing safety performance* (1984), Petersen describes the following elements of a safety system:

1. Management implementation of a sound safety policy
2. A defined hazard analysis process to minimize errors and oversights
3. Work situations with provide the environment and direction to enable people to perform capably and safely
4. An information system which provides
    a. Monitoring to promptly detect risks and deviations from safety plans
    b. Knowledge of hazards and corrective measures
    c. Prompt, and adequate feedback on safety performance
5. Opportunities to participate for all members of the organization, services and assistance to help them fully use their capabilities for developing and implementing safety measures, and recognition for good work on behalf of safety.

This basic framework may serve as areas of interest for performance measurement. "As a general rule selecting measuring devices use only activity measures at the lower managerial levels, primarily activity measures with some results measures at the middle-upper management levels, and reserve the pure results measures for the executive levels" (Petersen, 2003). In *Techniques of safety management: A systems approach*, on page 10, Petersen suggests performance measurements for the safety system to be utilized at prescribed levels in Table 2, on page 11.

Currently, there are various issues with safety performance. Within organizations in the United States, safety performance is a composite of the safety professional's knowledge, managerial and organizational preference, and Federal Government standards (Petersen, 1978).

Table 2
*Performance measures by organizational level**

Exhibit 6.2 Activities and results measures		
	Activity	
SUPERVISOR	**MANAGER**	**SYSTEM-WIDE**
For: Objectives Met	Objectives Met	Audit
# Inspections	Use of Media	-Questionnaires
# Quality Investigations	# Job Safety Analyses	-Interviews
# Trained	#Job Safety Observations	
# Hazard Hunts	#One-on-Ones	
# Observations	# Positive Reinforcement	
# Quality Circles	Group Involvement	
	Results	
FOR:	**MANAGERS**	**SYSTEM-WIDE**
SUPERVISORS	Safety Sampling	Safety Sampling
Safety Sampling	Inspection Results	Safety Performance Indicator
Inspection results	Safety Performance Indicator	# First Aid or Frequency
		# Near Misses or Frequency
	Estimated Costs	Property Damage
	Control Charts	Frequency-severity Index
	Property Damage	Estimated Cost Control Charts

Note. *from *Techniques of safety management: A systems approach* by D. Petersen, 2003, p.128

Safety performance is not standard from organization to organization; it is crucial for each individual organization to develop a system and performance measures that are incongruence with organizational goals. Classical safety performance measures are different than other organizational measures; they focus on absence of results.

Lagging indicators.

The safety profession as a whole predominately focuses on incident rates. These rates are lagging indicators, also known as results measures, they occur after a loss occurs. At present, the main focuses in many industries are OSHA incident rates. In Table 3 below, Zahlis and Hansen (p. 20) give several reasons why the industry focuses on these measures:

Table 3
*Ten reasons for using incident rates in safety performance measurement**

Incident rate metrics proliferate because:
1. Regulators require them;
2. Safety, Health and Environment (SH&E) profession tracks them;
3. Industry groups compare them;
4. Owners base huge contracts on them;
5. Authors cite them;
6. Rating bureaus use them;
7. Executives believe them;
8. Managers are rewarded based on them;
9. Administrators can manipulate them;
10. Using them is easier than performing.

Note. *from Zahlis, D. F. and Hansen, L. L. (2005, November). Beware the disconnect: Overcoming the conflict between measures and results. *Professional Safety*, 18-24.

Incident rates may reflect random fluctuations within the workplace (Dial, 1992). To effectively reduce and prevent the probability of a similar event, true causes must be found. By focusing on incident rates, the focus is directed to the outputs of a defective process. Issues revolving around incident rates are exemplified within working compensation costs. "National data confirm significant reductions in incident rates and lost-time compensable injuries over the past 10 years. Yet the average cost of medical and indemnity claims continue to escalate" (Zahlis & Hansen, 2005, p. 19). This demonstrates the need for new metrics and strategies because traditional measures and strategies are not working.

Lagging indicators consist of one area for safety performance measurement. There are various lagging indicators, such as, inspection results, costs, and property damage. The classical lagging indicators related to safety are the Occupational Safety and Health Administration (OSHA) incident rates, a number of rates are demonstrated in Table 4 (Webber, 2005), on page12.

The first OSHA incident rate in Table 1 is the Recordable Incident rate. This rate is the primary rate used by OSHA to compare occupational illness and injuries between various

Table 4
OSHA Incident Rates

Name	Formula
Recordable Incident Rate	$IR = \frac{\text{Number of OSHA Recordable Cases X 200,000}}{\text{Number of Employee labor hours worked}}$
Lost Time Case Rate	$\text{LTC Rate} = \frac{\text{Number of Lost Time Cases x 200,000}}{\text{Number of Employee Labor Hours Worked}}$
Lost Work Day Rate	$\text{LWD Rate} = \frac{\text{Total Number of Lost Days x 200,000}}{\text{Number of Employee Labor Hours Worked}}$
Days Away/Restricted or Job Transfer Rate	$\text{DART Rate} = \frac{\text{Total Number of DART incidents x 200,000}}{\text{Number of Employee Labor Hours Worked}}$
Severity Rate	$SR = \frac{\text{Total number lost work days}}{\text{Total number of recordable incidents}}$

companies across industries. The base rate of 200,000 for all of the rates is based upon 100 employees, working 40 hours a week, at 50 weeks per year. This rate is used so companies of varying size can determine a percentage of occupational illness and injuries per 100 employees (Webber). The next two rates, Lost Time Case and Lost Work Day, are used mostly for larger companies due to smaller companies tend to not have enough Lost Time and Work Days because of the decreased amount of employees (Webber). The Lost Time Case and Lost Work Day rates determine the number of lost time cases and lost work days per 100 employees within the company. The Lost Work Day rate has been replaced by the Days Away, Restricted, or Job Transfer (DART) Rate for recordkeeping purposes. As the name implies, the DART rate describes the amount of recordable incidents that resulted in days away, a work restriction, or job transfer. Lastly, the Severity Rate describes the number of lost work days per recordable incidents. All of these rates are used to describe the safety performance of a company. The Recordable Incident and DART rates are required to be reported to OSHA. Companies, whose

rates are higher than the Bureau of Labor Statistics (BLS) average of recordable incident rate and DART rate, are then targeted by OSHA for enforcement. The other rates provide more information regarding the performance of the safety system.

There are disadvantages associated with focusing on lagging indicators. For data collection purposes, lagging indicators are easily measured, however, no single type of measure can determine excellence; measurements need to be leading indicators of performance (Chakravarthy, 1986). There are large numbers of variables involved with lagging indicators. This is evident during an accident investigation, there is rarely one cause contributing to the outcome. Another example is individuals may choose to report an incident or not, thus greatly affecting the validity and reliability of the results measures. Due to the nature of the profession, lagging indicators are linked to bad news. When used correctly, there are also various advantages of lagging indicators. These indicators can be used for recording, investigating, and containing costs and be used in statistical performance control. At the system-wide level, these measures can be used over time as a quality check, when used over time (Petersen, 2003). Lagging indicators are easy to measure and often are tangible outcomes, such as, number of incidents and their associated workers' compensation costs. With their various advantages and disadvantages, lagging indicators are an important part of safety performance measurement.

Current and leading indicators.

"A primary purpose of safety is to develop intervention strategies to avoid future accidents." (Grabowski, Ayyalasomayajula, Merrick, & McCafferty, 2007, p. 405). By measuring before a loss or accident, leading and current indicators are more effective measures than lagging indicators for performance measurement (Dial, 1992). Leading and current indicators, also known as activity measures, are measures before a loss occur. By utilizing these

indictors and developing intervention strategies, they may be utilized to depict current system performance prior to an accident or loss occurring. By evaluating the current performance of the safety system, processes may be improved to reduce the occurrence of loss in the system.

There are various advantages for implementing current and lagging indicators in the safety performance measurement system. These indicators depict what is currently happening within the organization in relation to safety performance (Kunju Ahmad & Gibb, 2002). These measures do not affect productivity, financial resources, or employee morale. Examples may include completion of audits, training of employees, and safety related inspections, as well as, employee and management involvement. Leading and current indicators signify the current performance of the safety system. By indentifying issues within the system, process may be improved, and in turn, reduce an organization's exposure to risk by reducing the number of incidents in the workplace from a financial and liability standpoint by finding issues before a loss occurs.

There are disadvantages of leading and current measures. Internal measurements that indicate current performance rarely have a motivational effect (Eccles, 1991). This is due to the nature of these measures; they depict what is currently occurring in the system and often have intangible outcomes. Another issue associated with focusing on leading and current indicators, an organization may turn inwardly-focused. Organizations that are internally focused develop complacency through a false sense of security (Eccles, 1991). Depending upon the organization and the indicators they value, such as lagging, current, or leading indicators, those measures will drive motivation. This is further substantiated by the management axiom "what gets measured, gets done."

Developing Standards

A critical element of a safety system is the development of standards. Standards serve as the basis of measurement, evaluation, and improvement; they serve as the requirement of organizational performance (Bird & Germain, 1985). For an effective safety system, standards need to be developed for each element or process that has an impact on the system. Some example areas where standards may be used include management involvement, training, emergency preparedness, communication, and job analysis. Each organization is different and standards will vary, however, it is critical that these standards are developed with a cross functional group of individuals within the organization who may be affected by the standard. Individuals of interest may include management, line employees, human resources, or engineers. By developing safety system standards, preferred outcomes are defined and thereby change the focus to activity measures, as opposed to, result measures (Fulwiler, 1993). By defining standards of performance of the safety system, the end result is a total quality product (Fulwiler, 1993).

Quality of Activities

Once standards of performance are determined, activities performed may be evaluated (Bird & Germain, 1985). Quality of activities performed is a critical element for the safety performance measurement system. Simply performing an activity does not mean that the activity will have a desired effect upon the safety system. To overcome this, a rating system may be developed to describe the quality of the activity performed. Fulwiler (1993, p. 2) describes one way to numerically rate a system:

- 8 satisfactorily implemented and effective
- 6 implemented but incomplete or partially satisfactory

- 4 only partially in effect-results unsatisfactory-much room for improvement
- 2 some attempt has been made but no effective implementation.

Each element of the system may be rated internally and externally. A composite average score can thereby be determined to demonstrate the quality of the system for individual departments, divisions, or businesses. Scores may also be used in comparison with other metrics. Another approach in rating performance may be the utilization of percent compliance to a standard (Bird & Germain). An example may be percentage of employees trained in a department. Implementing a safety system framework may aide in the process of developing standards and evaluating the quality of performance of the system.

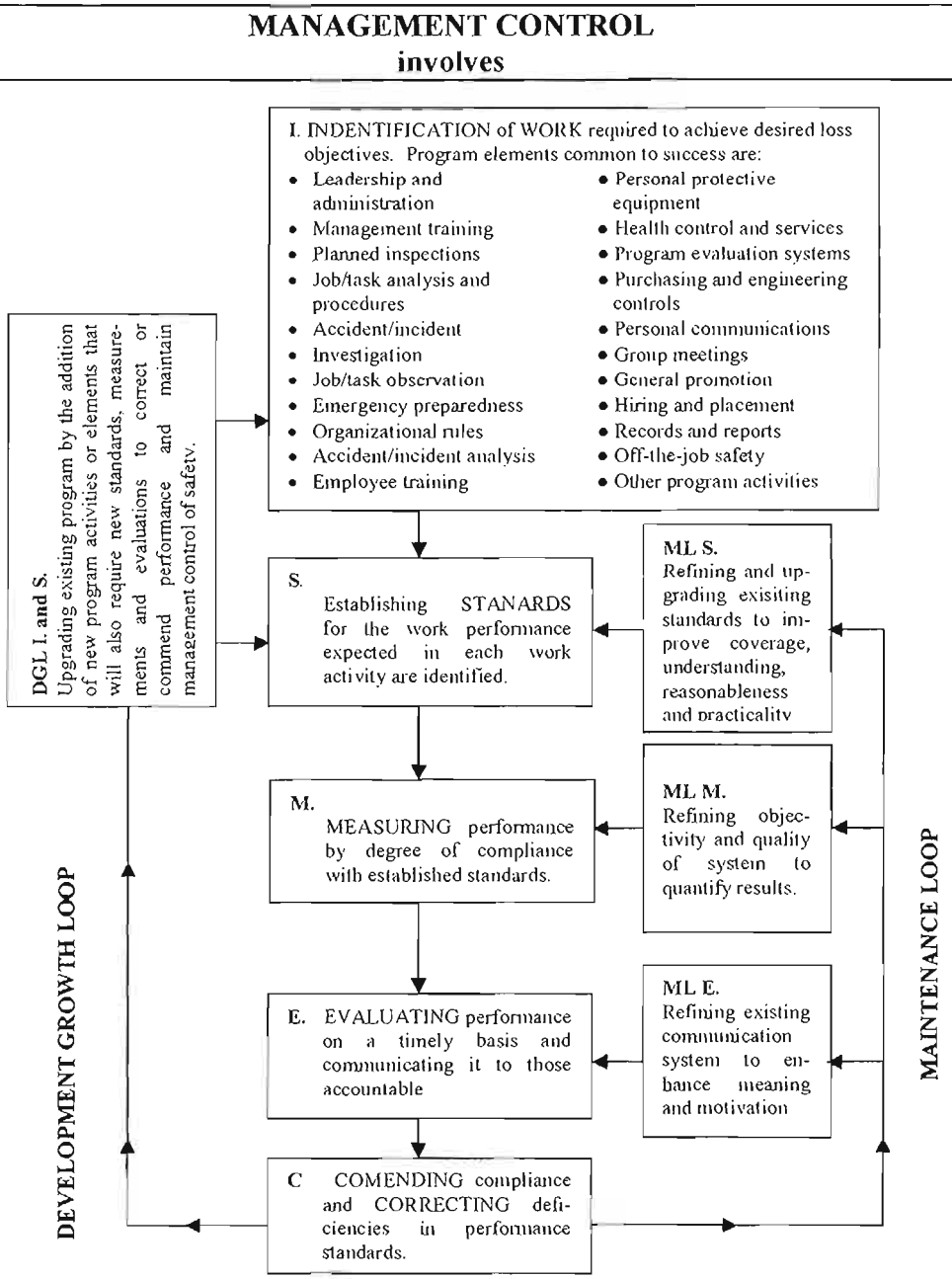
Safety System Framework

There are various models that may serve as a basis for the development of a safety system and standards. Example models include the ISMEC system, Occupational Health and Safety Assessment Series (OSHAS) 18001, and OSHA Voluntary Protection Program (VPP). Safety systems utilizing these models position themselves for proactive performance measurement. The ISMEC system and OSHAS 18001, specifically, have control loops that integrate continual improvement into the processes. Through these safety system frameworks, standards and elements may be developed for the utilization in safety performance measurement.

ISMEC system.

In *Practical Loss Control Leadership* (1985) by F.E Bird and G.L. Germain, the authors present information regarding safety management systems, including the ISMEC system. ISMEC is an acronym for Identification of Work, Standards, Measurement, Evaluation, and Commendation and Constructive Correction. The pictorial representation of this model is presented in Figure 1, on the following page. The first element in the ISMEC system is identification of work; within

Figure 1
ISMEC model



Note. *from Figure 3-4 Bird, F.E. and Germain, G. L. (1985). *Practical Loss Control Leadership*, p. 48

this section program elements are determined (Bird and Germain, 1985). By defining the work to be done, it is then possible to standardize, evaluate, and

measure the elements. The elements for identification of work that Bird and Geramin (1985) suggest in Figure 1, are aspects of a quality safety system. From these elements, the second section may be accomplished, establishment of standards (Bird and Germain, 1985). These standards are determined by individuals within the organization and should take into mind organizational objectives, which may include such initiatives as compliance and profitability. Standards are the basis for performance measurement; they define performance expected (Bird and Germain, 1985). Measurement of the system standards are then performed (Bird and Germain, 1985). An example they provide, "if your standard requires weekly inspections by each supervisor, but you only conduct three in a given month, you are a 75% performer regarding that specific standard" (Bird and Germain, 1985, p. 49). This illustration of measurement, demonstrates how accountability is affixed to individuals within the safety system. This aspect is crucial to align an organization to meet safety system goals and objectives. The next section of the ISMEC system is evaluation of performance, information assessed is based upon the results of the measurement. (Bird and Germain, 1985). Through this process, the amount of conformance to the standard is identified (Bird and Germain, 1985). Bird and Germain suggest in *Practical Loss Control Leadership* (1986, p. 49), to express the information in a percentage of conformance. This information allows an individual to know what standards are being conformed to, as well as, opportunities for improvement (Bird and Germain, 1985). The final step of this system is to commendation and correction; commend conformance and correct nonconformance to the standards (Bird and Germain, 1985). This step then completes the control loop, providing the system with a continual improvement process. With continual improvement and safety performance measurement, an organization may remain proactive in the prevention on occupational illnesses and injuries.

OSHAS 18001.

OSHAS 18001 is a safety system framework developed by British Standards Institution (British Standards Institution [BSI], 2010). This framework was developed to be able to integrate with other International Organization for Standardization (ISO) standards, such as ISO 9001 and ISO 14001 (BSI, 2007). These standards are respectfully concerned with quality and environment management systems. There are several benefits of this system they include: potential reduction in incidents, associated costs, and downtime, while increasing participation, improving management, and promoting a more proactive management system (BSI, 2010). Within OSHAS there are several elements that need to be implemented in order to conform to the standard.

Table 5
OSHAS 18001 System Elements

4.1 General Requirements
4.2 Occupational Health and Safety (OH&S) policy
4.3 Planning
4.4 Implementation and operation
4.5 Checking
4.6 Management review

Note. from BSI (2007) Occupational health and safety management systems-requirements

Table 5, above, highlights the necessary elements for conformance to OSHAS 18001. The first section of this system is General Requirements, it states "the organization shall establish, document, implement, maintain and continually improve an [Occupational Health and Safety] OH&S management system in accordance with the requirements of this OSHAS Standard and determine how to fulfill these requirements" (BSI, 2007, p. 5). Ultimately how to utilize this system is determined by the organization; however, there are various consultancies that may be able to offer advice on this regard. The next element is the OH&S policy, this aspect should be developed by top management and it is a statement of commitment by the organization regarding their intentions and principles for overall safety and health (BSI, 2007). This document affixes

the accountability for the organization to accomplish the requirements set forth within the system. The third element is Planning, to fulfill this requirement the organization must develop and uphold procedures for the following (BSI, 2007):

- Hazard identification, risk assessment, and determine controls
- Legal and other requirements
- Objectives and programs

The procedures planned and developed serve as standards of performance and are implemented into the system.

Implementation and operation, is the next element in OSHAS 18001 (BSI, 2007). There are several aspects within this element; they include (BSI, 2007):

- Resources, roles, and responsibility, accountability and authority.
- Competence, training, and awareness
- Communication, participation, and consultation
- Documentation
- Control of documents
- Operation control
- Emergency preparedness and response

The ultimate responsibility of the system is on top management (BSI, 2007). Top management is in control of the system, and as stated earlier, eighty percent of incidents are management controlled (Bird and Germain, 1985). This ensures that the system will be effective in preventing potential occupational illnesses and injuries. All individuals that may have an effect on the system must be aware, competent, and trained regarding the risks and elements of the safety management system (BSI, 2007). Communication is another important aspect of this

element. Procedures shall be in place for internal and external interests (BSI, 2007). This ensures that interested parties are aware of what is occurring and demonstrates an organizational culture of caring. Documentation and their control are important aspects of this element (BSI, 2007). By documenting and effectively controlling the documents it ensures a record of past performance, as well as, opportunities for improvement. By reviewing documents and records, process improvement objectives may be developed and implemented. The next aspect, operational control, is concerned with the management of occupational health and safety risks (BSI, 2007). Procedures in place should address deviations within the system, purchasing of goods, and other operations and activities that may have an effect on the system (BSI, 2007). The final aspect in the implementation and operation element is emergency preparedness and response; procedures shall be in place to address potential emergency situations and delineate authority in a potential situation.

The next element in the OSHAS 18001 system is checking; the various aspects of this element include (BSI, 2007):

- Performance measurement and monitoring
- Evaluation of compliance
- Incident investigation, nonconformity, corrective and preventive action.
- Control of records
- Internal audit

Procedures need to be established, implemented, and maintained to address all of the aforementioned aspects (BSI, 2007). For performance measurement quantitative and qualitative as well as, proactive and reactive measures shall be used (BSI, 2007). These measures should be appropriate for the organization and monitor the extent of conformance to prescribed

procedures (BSI, 2007). On regards to evaluation of compliance, the conformance to the OH&S policy, performance measurement, and legal requirements shall be examined; this ensures that policies and procedures set forth are being upheld (BSI, 2007). The next aspect is incident investigation, nonconformity, corrective and preventive action (BSI, 2007). To meet these requirements procedures in place should be used to effectively evaluate deviations in the system and thereby be effectively controlled to prevent future occurrences (BSI, 2007). Next, records used must also demonstrate conformity to this system (BSI, 2007). The final aspect is internal auditing; this aspect ensures that what is determined to be happening in the system, is actually occurring (BSI, 2007). This process shall be objective, as well as, impartial to ensure the quality of the auditing process (BSI, 2007).

The final element of this safety management system is management review (BSI, 2007). To ensure conformance with OSHAS 18001, top management must regularly review information regarding the status of the system (BSI, 2007). This ensures that management may be able make informed decisions regarding effective utilization of resources allocated to the safety management system.

OSHA VPP.

The OSHA VPP system, as the name implies, is a voluntary partnership between an organization and OSHA. There are four areas of interest in this system they include management and employee involvement, worksite analysis, hazard prevention and control, and safety and health training (OSHA, 2007). This program may serve as safety management system with the various elements serving as the basis for safety performance measurement.

The first aspect of this system is management leadership and employee involvement. Within this area there are several elements that must be addressed to ensure commitment from

every individual working for the company. The first element is managerial commitment to worker safety and health protection (J.J. Keller, 2009). The second element is clearly assigned safety and health responsibilities with documentation of accountability from top management to line supervisors (J.J. Keller, 2009). Safety and health protection is managed in the same way as productivity and quality (J.J. Keller, 2009). The fourth element is top management's personal involvement in the safety process (J.J. Keller, 2009). Management should evaluate and administer organizational safety management system goals and objectives. These goals should be evaluated on an annual basis and could be used to hold management accountable for low safety performance (Cooper, 2006). To fulfill the fifth and sixth elements of this area to complete annual safety and health program evaluations and integrate safety and health concerns into the organization's overall planning cycle (J.J. Keller, 2009). Regarding employee involvement, employees must be involved in activities that have a major effect on their safety and health program (J.J. Keller, 2009). "A positive safety culture is one where employees are actively involved in managing safety efforts, and safety management systems such as training and discipline are in place and effective" (Williams, 2008). Another element is adequate authority and resources must be given to given to line management and employees to improve the safety process (J.J. Keller, 2009). The next element is contract employees shall be provided the same quality of protection as employees (J.J. Keller, 2009). The final elements of this portion include a results-orientated safety policy and a written program adequate for the size of the industry (J.J. Keller, 2009). This area of the OSHA VPP system ensures that every individual that may have an impact on the safety management system is adequately involved in the process.

The second aspect of this system is worksite analysis; this area is to ensure quality and routine inspections of operations within the worksite (J.J. Keller, 2009). The first two elements include a method to identify existing or potential hazards in the workplace, as well as, documenting all identified hazards until they are eliminated or controlled (J.J. Keller, 2009). The third element is a pre-use analysis procedure for new processes, materials, or equipment to determine potential hazards (J.J. Keller, 2009). The pre-use analysis ensures potential hazards of innovation may be adequately identified and addressed, thereby reducing the organization to associated risks. Other elements in this area include routine site inspections, industrial hygiene monitoring, accident investigations, as well as, documentation of identified hazards and trend analysis of illness and injuries (J.J. Keller, 2009). By completing the various worksite analyses system conformance and deviations may be identified. By completing a trend analysis of the various hazards, illnesses, and injuries resulting information may be utilized to improve the safety management system (J.J. Keller, 2009).

The next area of the OSHA VPP system is hazard prevention and control. The first element is access to certified safety and health professionals (J.J. Keller, 2009). By providing access to this resource, quality information and expert insight into the safety system may be utilized. The second element includes engineering and administrative controls adequate for the hazards at the worksite (J.J. Keller, 2009). Depending on the severity and frequency of hazards, the hierarchy of controls should be utilized; they are (National Institute for Occupational Safety and Health [NIOSH], 2009):

- Elimination
- Substitution
- Engineering controls

- Administrative controls
- Personal protective equipment

For the third element, the organization shall have written safety rules and practices that are understood and followed by all employees. (J.J. Keller, 2009). The next element is a disciplinary system applied to all employees (J.J. Keller, 2009). This element is further substantiated by J. Williams in *Optimizing safety culture* (2008), in which he stated, "aggressive management system should include punishment". By providing punishment, it demonstrates that the organization will not tolerate deviations from the safety management system. The fifth element includes written rules for use and maintenance of personal protective equipment, as well as, ongoing monitoring and maintenance of workplace equipment (J.J. Keller, 2009). Equipment must be evaluated and maintained to ensure it is working to specifications or if replacement is necessary. The sixth and seventh elements are hazard correction tracking procedure and use of occupational health professionals in hazard analysis as appropriate (J.J. Keller, 2009). Occupational health professionals may provide key insight into issues that may not be adequately addressed otherwise. Access medical services and emergency services are another element for hazard prevention and control (J.J. Keller, 2009). In the occurrence of an emergency, it is critical to have these resources available to reduce the severity of potential consequences. The last element for hazard prevention and control is written plans for emergency situations (J.J. Keller, 2009). By effectively preventing and controlling hazards, an organization can greatly reduce injuries and illnesses to employees, as well as, reducing associated costs of treating these occurrences.

The final area of this system is safety and health training (J.J. Keller, 2009).This aspect verifies the effectiveness of training given to ensures employees acquire a skill set to effectively

work safely within the process. The first element of this area is manager, supervisor, and employee training with emphasis on safety and health responsibilities (J.J. Keller, 2009). Every individual within the organization have an impact on the safety system; by training them on their safety and health responsibilities they will be knowledge and accountable for their impacts on the system. Documentation of all training received and including assessment procedures are also associated requirements for this element (J.J. Keller, 2009). The next element is training of employees in the use and maintenance of all necessary personal protective equipment (J.J. Keller, 2009). Personal protective equipment serves as a line of defense against various hazards. If the equipment is compromised; the protection provided is greatly reduced or eliminated. The final element of this area is emergency preparedness drills, including annual evacuations (J.J. Keller, 2009). Through the various trainings and procedures, management and employee involvement is encouraged in the safety management system (Williams, 2008). Safety and health training is an important part of any safety management system.

Statistical Process Control (SPC) Tools for Safety Performance Measurement

To measure safety performance, there are various techniques and strategies to be utilized. By using leading, current, and lagging indicators metrics used can depict the health of the safety system. Certain metrics are appropriate for different levels of safety performance, and are depicted in Table 2 above (Petersen, 2003). Namely metrics used for safety performance include Pareto charts, histograms, scatter diagrams, control charts, and process capability.

Pareto charts

Pareto charts are used to identify and evaluate factors that contribute to the frequency of unwanted events (Janicak, 2002). The charts demonstrate the Pareto Principle; a majority of issues are caused by a few factors. In a Pareto chart, information is aligned in descending order

from the greatest frequency to the smallest. In relation to safety, Pareto chart would indentify issues that result in the largest number of accidents in accordance to frequency, however, it does not take into account severity (Janicak, 2002).

Histograms.

Histograms depict information across a sample or population. In relation to safety, histograms can be utilized to demonstrate cost per accident, amount of training completed, or number of lost work days (Janicak, 2002).

Scatter diagrams.

Scatter diagrams are graphs that can determine a relationship, or correlation between two data points (Janicak, 2002). Depending on the depiction of the graph, the relationship may be positive, negative, or no correlation.

Statistical process control (SPC) charts.

This statistical tool is beneficial for safety performance measurement. Every organization has a "stable" baseline number of occurrences. (Grant & Leavenworth, 1972). By using a SPC chart, the variance from the stable baseline may be determined, thereby demonstrating deviations from the norm. Within a safety management system, standards and guidelines identify how processes shall be performed. As Grant and Leavenworth (1972) stated, SC charts demonstrate performance. These charts identify variation in performance and if it is at or above standards and guidelines suggest, as well as, where there are opportunities for improvement.

There are two causes of variation. The first source is common causes; these are due to small sources of variation within the system (Summers, 2006). These variances are present in the system and are part of the normal variation of the process and cannot be avoided (Summers,

2006). The second source is assignable cause; this variation is not part of the normal variance within the system and arises for specific reasons (Summers, 2006). Assignable causes may be negative or positive for the system. For example, when measuring completion of scheduled inspections and the number is increased for one month, this is considered a positive assignable cause. Conversely, if it the number of injuries that is increased, this would be a negative assignable cause. A root cause analysis should be conducted to determine the cause of these events to prevent future occurrences. There are various types of charts that can be used to analyze a safety management system.

The c-chart is used for the number of events in a given period of time. This can be used for number of cases to be examined per month. The limits can be calculated by the following formula (Summers, 2006):

$c \pm 3\sqrt{c}$ where c = average number of events per period

A chart is considered out of statistical control if any of the following are true, and demonstrates that a special case has occurred (NHS Institute for Innovation and Improvement, 2009):

- A single point is outside of the lower control limit (LCL) or upper control limit (UCL)
- Seven points are all above or below the center line
- Any unusual patterns within the chart, such as, continually increasing or decreasing

The second chart is the p-chart; this can be used to determine the fraction of areas in nonconformance and sample is of varying size (Summers, 2006) An example when to utilize a p-chart is when determining the percent of individuals injured per month. The following formula is used to determine the p-chart limits (Summers, 2006)

$p \pm 3\sqrt{[p(1-p)/n]}$ where p=average fraction defective and n= sample size per period

The final chart is the u-chart. According to Summers (2006, p. 480), "[the] u-chart is a chart that studies the number of nonconformities in a unit". This chart can be used to analyze rates of injuries or people completed training on various safety related procedures. This chart is similar to the c-chart, however, it is utilized when the sample size varies (Summers, 2006) The following formula is used to develop a u-chart:

$u \pm 3\sqrt{u/n}$ where u= average number of events and n=sample size.

Process capability.

Process capability is a quality measure utilized to determine if the given process outcomes are able to perform to expectations (Janicak, 2002). This information is lends itself nicely to safety performance measurement because it can inform if processes are capable of performing as required. An example is within a ventilation system, given certain specification limits and the system cannot perform, employees may be negatively affected (Janicak, 2002).

Summary

Performance measurement is a critical aspect of any organization. "What gets measured gets done", and through this process, it affixes accountability for the organization. By overcoming the various issues of performance measurement, such as resistance to change and system integration, the process will greatly help an organization to remain in operation. Through continual improvement and efficiency, the organization can accomplish organizational goals. This is especially true when it comes to safety performance measurement. As Pope (1990) suggested 'safety' is another term for error-free performance.

To effectively measure safety performance, lagging, leading, and current indicators are necessary to fully depict organizational performance. Currently within the United States, many industries focus on lagging indicators for safety performance measures. There are various

reasons including ease of use, preference, and requirement (Petersen, 1978). To be a more effective organization, leading and current indicators should be utilized in congruence with lagging indicators. Example measures include completion of training, employee and management involvement, and completion of accident investigations. With the use of various safety system models, an organization may efficiently and efficiently measure safety performance. There are various safety performance measurement metrics that could be used; they include, Pareto charts, histograms, statistical control charts, among many others (Janicak, 2002).

As industry and organizations become more competitive and resources become less available, it is critical to analyze organizational performance. By evaluating safety performance, management may be able to utilize resources more effectively. The process of safety performance measurement results in a more efficient and profitable organization. There is a need for organizations to focus on all safety performance measurements, leading, current, and lagging indicators.

Chapter III: Methodology

The purpose of this study was to develop a safety performance measurement system that focuses on current and leading indicators. This study specifically evaluated quantitative and qualitative information to depict current safety system performance at Company XYZ. Through this study, a framework was developed to include current and leading indicators for safety performance measurement to be implemented at Company XYZ.

The objectives of the study were to:

1. Identify and evaluate the current process used to measure safety performance at Company XYZ.
2. Demonstrate the applicability of using various statistical process control tools to measure safety system performance.
3. Develop a process that would produce data that could be used to determine pro-active safety system performance.

This chapter includes descriptions of the various methods used to evaluate Company XYZ's current safety performance measurement system. Within this chapter the instrumentation, data collection procedures, data analysis, and limitations of the study are discussed.

Instrumentation

A semi-structured interview process was utilized to extract information regarding current viewpoints of safety performance at Company XYZ. A copy of this format is in Appendix A. The primary aspects discussed were the awareness, problems, and suggestions regarding safety performance at Company XYZ.

Data Collection Procedures

Data collection was used through qualitative and quantitative research methods to identify and evaluate the current safety performance measurement system. First of all, a semi-structured interview was utilized to identify current viewpoints. This interview format was utilized to obtain more information if required for analysis. Secondly, statistical process control tools were employed to evaluate current system performance. Third of all, the literature review was utilized to develop a process that could be used to determine pro-active safety system performance.

Participants in a semi-structured interview provided qualitative information regarding current viewpoints of Company XYZ's safety system performance. Subjects for the interview were selected by department and title and Company XYZ. Two participants, one within the safety department and another outside of the department, participated in the interview. The format of the interview was utilized to elicit information describing current viewpoints of safety performance at Company XYZ.

To accomplish Objective 2: demonstrate the applicability of using various statistical process control tools to measure safety system performance; information regarding workers' compensation costs, occupational illnesses and injuries, and incident rates were evaluated quantitatively through utilization of various SPC tools. This information was provided by safety and health professionals currently employed at Company XYZ.

Lastly, to accomplish Objective 3: Develop a process that would produce data that could be used to determine pro-active safety system performance; information from the literature review was utilized.

Data Analysis

Upon completion of the interviews, data analysis was conducted to determine how the current safety system was performing. Information utilized included the following:

- Occupational injuries and illness by type and location
- Workers compensation costs
- Incident rates

To address the objectives of the study, statistical process control tools were used to measure current safety system performance. Tools utilized include the following, Pareto chats, scatter diagrams, and SPC charts.

All data collected was used to compare with the overall best practices of safety performance measurement. First of all, current viewpoints were analyzed. Secondly, the applicability of various SPC tools to demonstrate safety system improvement was examined. Finally, this information was then used to develop a process that would produce data that could be used to determine pro-active safety system improvement.

Limitations

1. Due to the analysis of only one organization, validity of the information is minimized without further study.
2. Information collected through the semi-structured interview may not demonstrate the participants true sentiments regarding Company XYZ's safety system performance.
3. Information collected through the data provided for quantitative analysis is only reliable as the information provided.

4. Data regarding current performance measurement may be affected by the various nuances and dynamic nature of Company XYZ's safety climate on the current safety system.

Chapter IV: Results

The purpose of this study was to develop a safety performance measurement system that focuses on current and leading indicators for Company XYZ. The objectives of the study were to:

1. Identify and evaluate the current process used to measure safety performance at Company XYZ.
2. Demonstrate the applicability of using various statistical process control tools to measure safety system performance.
3. Develop a process that would produce data that could be used to determine proactive safety system performance.

To achieve the objectives of the study, the methodology utilized a review of literature, semi-structured interview, and quantitative evaluation utilizing statistical process control tools. First of all, to accomplish the first objective, a semi-structured interview was conducted to identify and evaluate the current process used to measure safety performance at Company XYZ. The interview obtained information from two participants, one within and one outside of the safety department, regarding individual viewpoints of the safety performance at Company XYZ. The results are located in Tables 6, 7, and 8 below. Next, to complete the second objective, determining the applicability of various SPC tools to measure safety system improvement; SPC tools and a literature review were utilized to evaluate Company XYZ's current safety system performance. Finally to accomplish the third objective, a review of literature was utilized in congruence with the results of the prior instrumentation to develop a process that would produce data that could be used to determine proactive safety system improvement.

Results from Semi-Structured Interview

Table 6
Safety System Awareness, Problems, and Suggestions
Objective 1: Identify and evaluate the current process used to measure safety performance at Company XYZ.

Question 1:	*How is your current safety system structured?*
Response 1:	Reactionary, I don't think we are proactive as we could or should be. There are currently no incentives; safety becomes an important after an incident or numbers are bad. We measure using lost LWCIR, TCIR, Safety Training Completion. Not a lot of follow-up on the numbers; departments have meetings, others don't. Safety isn't the same as quality and productivity. If you don't make the numbers, the rest doesn't matter. We have a safety committee and "walk arounds".
Response 2:	We have a main safety committee, regulatory compliance, and programs. Monthly safety training, departmental safety teams, departmental and management audits, corporate audits, new employee orientation, main things to think of offhand. We also have a Hazmat team and first responders, as well as, pre- and post-accident drug testing
Question 2:	*Who are the individuals involved?*
Response 1:	Safety Specialist and EHS Manager; General Operations Manager and Production Manager when need be.
Response 2:	All employees, managers, and supervisors; essentially everyone
Question 3:	*What are your concerns regarding safety at Company XYZ?*
Response 1:	Compensation costs are higher than should be; costs per capita are higher than other locations. We have to change the culture of folks here. One thing you have to work together to reduce false reporting. Have to be careful of incentive programs, they may skew reporting. Personally know of workers falsely reporting workers' compensation claims. We have an older workforce and we also need to educate employees about work-related injuries, as well as, how outside hobbies can affect injuries.
Response 2:	Reduction in late reporting, currently results in disciplinary action. Often drug tests are not completed on time even though it is in documentation and communication. Lack of employee involvement, no new people on safety committee not a lot of "new blood"; on a volunteer basis.
Question 4:	*What are some opportunities for improvement?*
Response 1:	Working with insurance company more and educating people about the costs can do to the organization. Awareness of some type of a program, met a goal had a lunch, it was a big deal.
Response 2:	Do a better job of holding employees, managers, and supervisors holding accountable for safety performance. No more read and signs for training. Out on the floor, physically present. Have more safety performance driven goals; example 95 % safety training goals, although nobody goes back to make-up. On time incident reporting and incident investigations employee and supervisors according to requirements and for performance reviews. One managerial audit per 100 employees, so 12 a year and one internal audit a month per department. Having a number of safety audits completed per department, every month develop standard actions recorded in corrective actions. Individual not really enforced from the managers, it is overlooked at times.
Question 5:	*How could these concerns be overcome?*
Response 1:	Expectations aren't there and nobody is requiring it. Increasing accountability and challenge things. When I first came to Company XYZ we experienced a lot of back injuries and still do. Most of our injuries are backs, shoulders, and carpal tunnel.

	Specifically looking at jobs; there is a lot of repetitive motion. Rotation, supervisors find someone good at a job then lose the person due to repetitive stress, numbers appear to be more important than safety. In the short-term produces numbers, however, in the long-term lose employees due to injuries.
Response 2:	I take a two prong approach, re-inform and make clear expectations and then take disciplinary action. Mangers a better job of soliciting volunteers. Let us know about individual talents and attributes, i.e. EMT or interest is safety committee)

Table 7

Safety System Performance Measurement Awareness, Problems, and Suggestions

Objective 1: Identify and evaluate the current process used to measure safety performance at Company XYZ.

Question 6:	*How is Company XYZ's safety system currently measured?*
Response 1:	Measured by experience modifier comparing against in industry and other locations at Company XYZ. Quarterly meetings compare incident rates against last year's incident rate and target rate. I think they like to see a percentage of reeducation.
Response 2:	We have TCIR, LWCIR, Training completion percentage per month. Worker's compensation dollars spent. Number work days since lost work day case.
Question 7:	*Who utilizes the information?*
Response 1:	Good question, Corporate and Operations manger beyond that I don't know.
Response 2:	Leadership team managers, directors and Health and Safety. Track how we are doing in a monthly leadership meeting. Corporate reviews OSHA log and man hours quarterly
Question 8:	*What are your concerns regarding how safety performance is measured?*
Response 1:	Though one, I guess it is always a problem in safety. One incident can be so expensive or days lost time can work as hard as ever and nothing. When looking at lost days or frequencies are deceptive. A severe incident can throw you off. Can go a long time and nothing happens. So much affects safety. Have to be lucky to have a good safety record culture and all that stuff affects it.
Response 2:	I think it's not driven down enough to a departmental level, its fine to say we want our TCIR reduced. Manager may not be interested in pursuing corrective actions with poor incident rate performance, may be how its presented
Question 9:	*What are some opportunities for improvement?*
Response 1:	A right incentive program and educates people and their focus. To make too. Past experience one middle/report all and one nothing, don't like results. Improve statistically bring people back as soon as possible.
Response 2:	Set a departmental goal, as well as, facility goals that we currently have. Do a departmental basis. Currently, we look at our history and upper management reviews past performance and determines percentage of reduction of rates to attain as a goal for the year.
Question 10:	*How could these concerns be overcome?*
Response 1:	Doing the best we can do, that is the best you can do and be happy about that. If I saw someone working their tail off and have a bad safety record, not as big of a deal if something not working right
Response 2:	Maybe it's more in the presentation of data; if it was more obvious then maybe it would stand out. Everybody should be concerned, not just Health and Safety, create more of an interest; improve presentation of data to everybody, like "here is how your department measures against everyone else". We could recognize meeting safety completion goal, not just tied into incident recordables

Table 8
Safety System Performance Awareness, Problems, and Suggestions
Objective 1: Identify and evaluate the current process used to measure safety performance at Company XYZ.

Question 11:	*How is your safety system currently performing?*
Response 1:	I guess adequately
Response 2:	I think we are doing ok, no glaring holes, certainly something that can always be improved.
Question 12:	*What are some major issues in the safety system performance?*
Response 1:	More emphasis on environmental because of waste treatment and emissions, less emphasis on safety Used to have more people in the department used to be 5 or 6 and now there is 2, much like other areas of the business
Response 2:	Nothing sticks and increase interest at all levels; maybe not major but a wish list to like to see.
Question 13:	*What are some opportunities for improvement?*
Response 1:	Automation, process improvement, making things less labor intensive, some robotics, less exposure to equipment.
Response 2:	More employee involvement, holding people accountable more than we currently do.
Question 14:	*How could Company XYZ safety performance be improved?*
Response 1:	Educate, train, and recognize with reward.
Response 2:	We measure training; we could hold departments more accountable a more active role in performance. Make sure audits are done, set departmental goals. Basically what we have been talking about through this interview.

The interview conducted elicited various viewpoints regarding the safety system at Company XYZ. There are various elements to the safety system structure; however, one respondent suggested that this system was reactionary. One respondent suggested that everybody was involved in the safety system, while the other stated that a select few people were involved. This may suggest that employee involvement needs to be increased. A successful system would have all employees actively involved and utilize a safety management system (Williams, 2008). Through this process accountability may be also be increased, another viewpoint shared between the respondents and expressed throughout the interview. The safety system performance measurement at Company XYZ is based off of reactive measures and percentage safety training completion. Respondents suggested opportunities for improvement including presenting the data differently, more incentives, and setting departmental goals. These suggestions may assist in the increase of accountability and employee participation in the safety

management system. When questioned about the performance of the safety system, both respondents both responded slight affirmatives. This may suggest lack of assurance in the current system, thereby suggesting a need for a change.

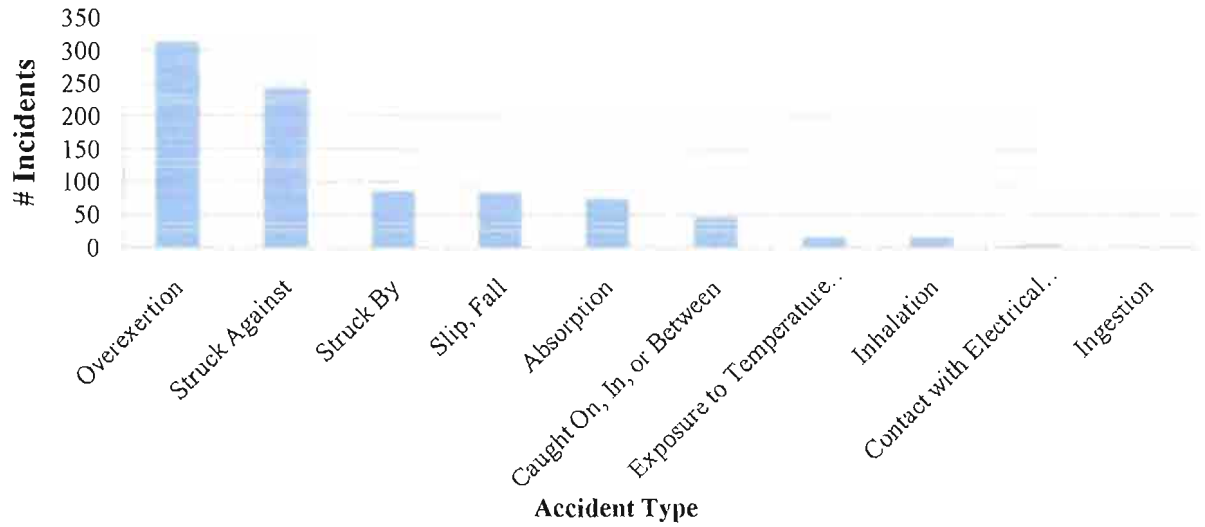
Results from Statistical Process Control Tools

Tools used for the analysis of current safety performance at company XYZ included Pareto charts, scatter diagram, c-chart, and u-chart. These tools were to demonstrate the applicability of SPC tools to measure safety system improvement. Although this analysis is not an exhaustive study of the current system, the tools demonstrated various ways to demonstrate how the current safety system is performing, as well as, identifying opportunities for improvement. Table 9, on the following page, includes the results of the statistical process control tools, along with interpretations of the results.

Table 9
Quantitative Analysis of Data
Objective 2: Demonstrate the applicability of using various statistical process control tools to measure safety system improvement.

Pareto Analysis:

Graph 1
Injury/Illness by Accident Type

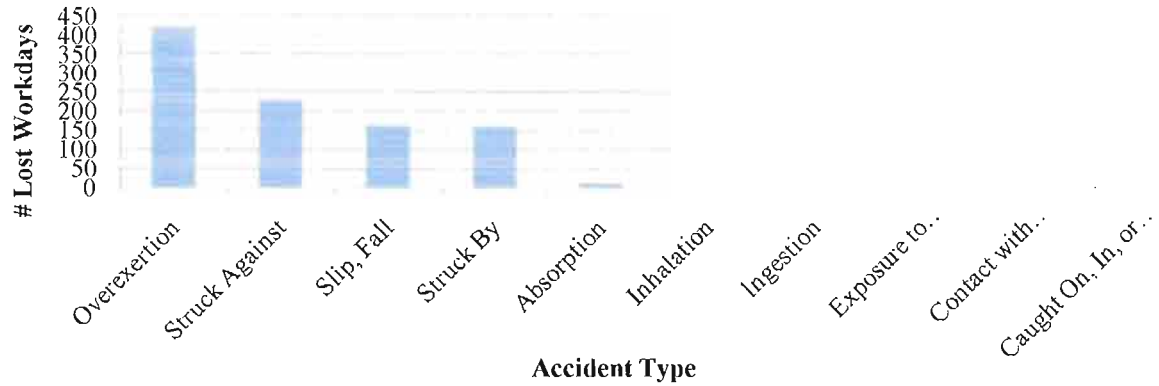


In Graph 1 above, the number of occupational injuries and illnesses were ranked by accident type. Overexertion, struck against, struck by, and slips/falls accidents accounted for the greatest number of illnesses and injuries at Company XYZ. These accidents account for 82% of accidents experienced at Company XYZ. Overexertion injuries include such things as pain, strains, and tendonitis; examples of struck against accidents include cuts, lacerations, punctures, and foreign bodies. Slips and falls may result in bruises, contusions, pain, and strains.

Graph 2 below, the number of lost workdays was ranked by accident type. Overexertion, struck against, and slips/falls accidents accounted for the greatest of lost workdays at Company XYZ. These accidents account for 83% of lost workdays experienced at Company XYZ.

Graph 2

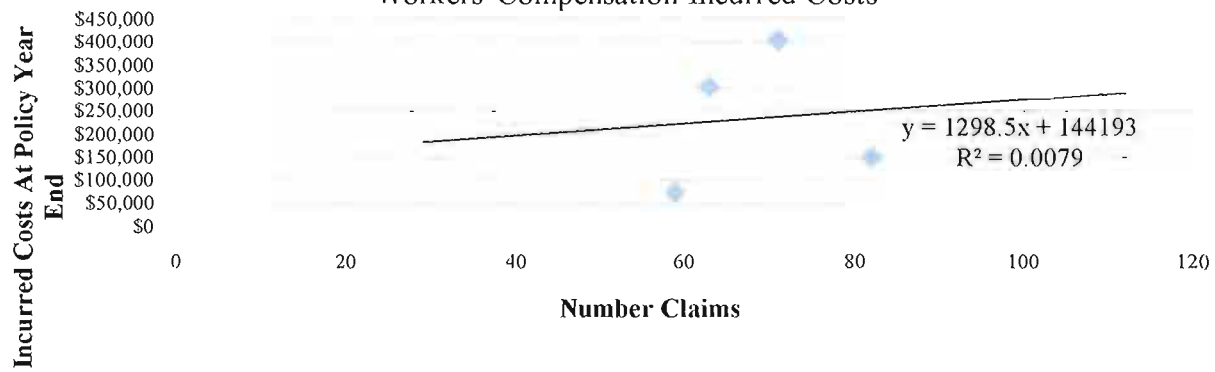
Lost Workdays by Accident Type



Scatter Diagram:

Graph 3

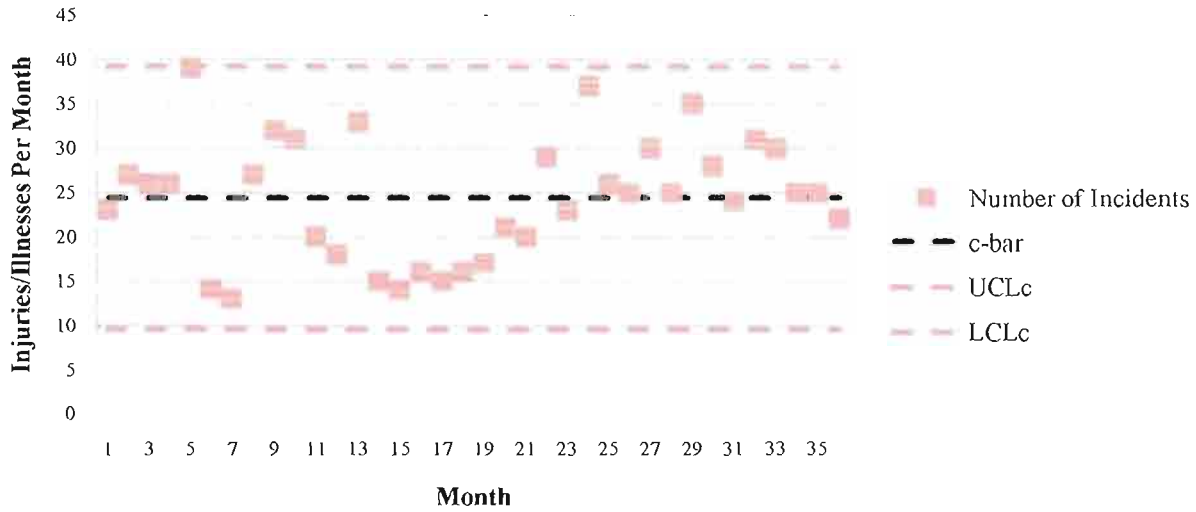
Workers' Compensation Incurred Costs



Graph 3, above, demonstrates a positive correlation between the number of claims compared to the amount of workers' compensation incurred costs. This graph depicts an increasing trend, therefore cost will become more of an issue for Company XYZ in the future as incidents occur.

c-Chart:

Graph 4
c-Chart for Injuries/Illnesses Per Month 2006-2008



The number of nonconformities chart, or c-chart, is used, "to track the count of nonconformities observed in a single unit of product or single service experience" (Summers, 2006, p. 473). The c-chart may be used with occurrence-reporting data, such as injuries and illnesses per month (Janicak, 2003). In Graph 4, above, this chart represents the injuries and illnesses experienced at Company XYZ over three years. Graph 4 appears out-of-control for various reasons, they include:

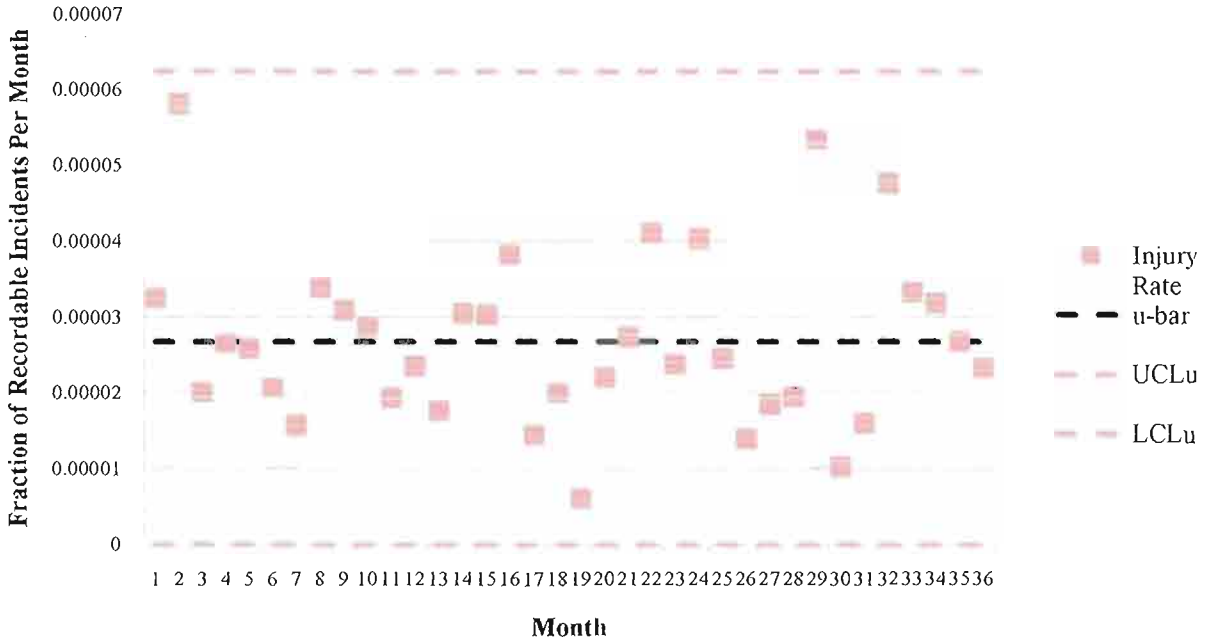
- Several points are at or close to control limits
- There is a run of more than seven points
- The pattern in the data appears to be somewhat oscillating

Since the c-chart is out of control, this suggests that the current system is not contributing to the success or failure of the safety system.

u-Chart:

The u-chart, also known as the number of nonconformities per unit chart, is used when the sample has variable sizes (Summers, 2006). A u-chart lends itself nicely when evaluating incident rates due to the number of man-hours (i.e. sample size) varying from month to month (Janicak, 2003). In Graph 5, below, the number of recordable incidents per month, over a three year span, is depicted.

Graph 5
u-Chart for Recordable IncidentsPer Month



Based upon the various points of the chart, it appears to be out of control. Reasons include the following:

- Points within the vicinity of limits
- Appears to be an oscillating trend

Results from Literature Review

To accomplish the third objective, information from the literature was utilized to develop a process that would provide safety performance measurement. As stated earlier, safety performance is not standard from organization to organization; it is crucial for each individual organization to develop a system and performance measures that are incongruence with organizational goals. To successfully develop a successful safety performance measurement system, a safety system management system should be utilized. Example systems include OSHA VPP, OSHAS 18001, and the ISMEC system. Once the management system is identified standards shall be identified, these serve as the basis of measurement (Bird & Germain, 1985). These standards bring the focus to desired outcomes, thereby resulting in the use of activity

measures (Fulwiler, 1993). After identification of standards, evaluation of system performance may be conducted. This may be accomplished through evaluating the conformance and quality of activities that have an effect upon the safety system. Conformance may be expressed as percent of compliance to the applicable standard (Bird & Germain, 1985). Various levels of employees should utilize different performance measures when evaluating system safety performance (Petersen, 2003). Managers and supervisors should focus on leading indicators, while lagging indicators may be utilized when focusing on evaluating system-wide performance (Petersen, 2003). By management focusing on proactive measures, poor behaviors may be corrected before a loss occurs. When evaluating the system quantitative and qualitative, as well as, reactive and proactive measures should be utilized (BSI, 2007).

Once conformance has been identified, corrective actions may be utilized to reward or improve system safety performance. The information should be timely and provide feedback regarding safety performance (Petersen, 1984). This may be accomplished through the utilization of various statistical process control tools and publishing the information system-wide. Examples may include monthly reports, "report cards" posted at each entrance of a department, or during monthly safety meetings. The results of the evaluations should be evaluated on a regular basis and could be used to hold management accountable for low safety performance (Cooper, 2006). Through this safety performance measurement system, leading indicators will become the basis of measurement while increasing management accountability and employee involvement.

Summary

The purpose of this study sought to describe how Company XYZ can implement current and leading indicators to measure their safety performance. This chapter provided a discussion

of the results of collected by the study. The first objective was to identify and evaluate current viewpoints of the safety system at Company XYZ. A semi-structured interview format was utilized to obtain various viewpoints of the current safety system. The awareness, problems, and suggestions regarding the safety system, safety system performance measurement, and safety system performance were discussed. The individuals' responses are highlighted in Tables 6, 7, and 8 above. The second objective was to demonstrate the applicability of statistical process control tools to measure safety system improvement. By utilizing a literature review, as well as, evaluating current and past data, the current system may be evaluated to quantitatively measure system performance. The third objective was to develop a process that could produce data that would demonstrate proactive safety system improvement. Through the literature review, three safety system frameworks were discussed. These systems, as well as, other information serve as the foundation for the process developed that would elicit proactive safety system performance at Company XYZ. The information gathered regarding safety system performance at Company XYZ, are the basis of the conclusions and recommendations that are presented in Chapter V.

Chapter V: Summary, Conclusions, and Recommendations

Restatement of the Problem

Incident rates and other lagging indicators are often unreliable measures of safety system performance. By utilizing proactive measures, such as leading and current indicators, an organization would be able to effectively benchmark safety system improvement.

Purpose of the Study

The purpose of this study was to describe how Company XYZ can implement current and leading indicators to measure their safety performance.

Goals of the Study

1. Identify and evaluate the current process used to measure safety performance at Company XYZ.
2. Demonstrate the applicability of using various statistical process control tools to measure safety system improvement.
3. Develop a process that would produce data that could be used to determine safety system performance

Methods and Procedures

To accomplish the goals of the study, the methods consisted of semi-structured interviews, statistical process control tools, and literature review. These procedures presented information about the current safety system at Company XYZ and how proactive indicators may be utilized to measure safety system performance.

A semi-structured interview was conducted onsite with one individual inside and one outside of the safety department. This information was utilized to attain the first goal; identify and evaluate current processes used to measure safety performance at Company XYZ. Various

viewpoints were elicited on regards the safety system, system performance measurement, and system performance.

Statistical process control tools were utilized to achieve results regarding the second goal of the study. The second goal sought to demonstrate the applicability of various SPC tools to measure safety system improvement. A Pareto analysis of injury/illness and lost workdays by accident type was conducted to determine the largest contributors to accidents at Company XYZ. To analyze workers' compensation claims, a scatter diagram compared number of claims and total costs to the organization. SPC charts were utilized to evaluate incident rates at Company XYZ. A c-chart was used to evaluate the injuries and illness per month, while a u-chart compared recordable incidents per month. Finally, a literature review was utilized to provide information to develop a process that would produce stat that could be utilized to determine safety system performance.

Safety system performance evaluation is a critical element of success for an organization. Through evaluation, opportunities for improvement within the system may be elicited. To be successful management must be concerned with the improvement of processes to attain goals while eliminating inefficiencies (Pope, 1990). By determining and effectively controlling issues within the system, accidents and associated costs may be prevented or reduced. By utilizing more activity measures, current safety system performance may be better depicted and thereby improved. Through the process of identifying, evaluating, and controlling issues in the safety system, Company XYZ may be able to efficiently and effectively attain organizational goals and objectives.

Conclusions

Objective 1 was to identify and evaluate the current process used to measure safety performance at Company XYZ. Based upon the results of the study the following conclusions were made:

- First of all, the current safety system is mainly based on reactive indicators. By basing the current system on reactive indicators, the focus may be directed to adverse consequences of a defective process. By focusing on management of the system, eighty percent of incidents could potentially be avoided (Bird and Germain, 1985). Reactive indictors may only reflect random fluctuations within the workplace (Dial, 1992)
- Secondly, the current safety system is not viewed that same as productivity and quality. Safety and health protection should be managed in the same way as productivity and quality (J.J. Keller, 2009). By treating safety differently than productivity and quality, perceptions of the importance of safety may be diminished.
- Finally there is need to increase accountabllitiy and employee invovlement. Eighty percent of incidents are management controlled (Bird and Germain, 1985). By increasing accountability of management regarding the performance of the safety system, a majority of incidents may be reduced or eliminated. Regarding employee involvement, employees must be involved in activities that have a major effect on safety system performance (J.J. Keller, 2009). "A positive safety culture is one where employees are actively involved in managing safety efforts, and safety management systems such as training and discipline are in place and effective" (Williams, 2008).

Objective 2: Demonstrate the applicability of using various statistical process control tools to measure safety system improvement. The following conclusions were made based upon the results:

- First of all, in Graph 1, overexertion, stuck by and against, and slips and falls account for 82 % of the accidents; while in Graph 2, 83 % of the lost workdays at Company XYZ. By focusing on intervention strategies on these incidents, the number of incidents, lost workdays, and associated costs may be reduced.
- Secondly, by reducing the number of claims, amount of money saved on workers' compensation insurance will be positively affected.
- Next, data suggest in Graph 4 that the current safety system at Company XYZ appears to be out of control. This demonstrates the need for process improvement in the reduction of occupational injuries and illnesses. Further evaluation should be considered on the various processes in place that have impacts on the current safety system performance.
- Finally, the u-chart in Graph 5, suggests that the recordable injuries per month has an oscillating trend and points are in proximity of control limits thereby demonstrating a lack of control over incident rates. This may suggest lack of consistency in reporting or cyclical variation due to business.

Objective 3: Develop a process that would produce data that could be used to determine safety system performance.

- Company XYZ may be better served with a formal safety management system, such as OSHAS 18001, OSHA VPP, or ISMEC and have the various elements serve as the basis of performance measurement. Currently the safety system is reactive in nature. By utilizing a formal management system, the various elements are indtified and may align Company XYZ to better employ curren and leading indictors of safety performance.

- Current and leading indicators would better serve the organization to evaluate safety sytem performance, as opposed to incident rates and other lagging indicators.
- As Bird and Germain (1985, p. 32) stated in *Practical Loss Control Leadership*, "80% of the mistakes people make involve things that only *management* can do something about. Therefore, it is necessary to hold managers accountable for safety system performance.

Recommendations

Based upon the results of the study the various recommendations were made regarding the current safety system at Company XYZ

- To reduce the number of accidents and lost workdays, quality intervention strategies should be focused on the prevention of overexertion, struck by and against, and slips and falls accidents. These accidents account for over 80% of losses experienced at Company XYZ, by reducing these incidents the majority of accidents will be reduced. Associated costs and negative consequences, such as lost workdays and working restrictions, may be reduced.
- Quality interventions and strategies should be focused on the reduction of frequency and severity of overexertion, struck by and against, as well as, slips and falls injuries and illnesses. These areas for improvement may have the greatest return on workers' compensation costs.
- Next, data suggest in Graph 4 that the current safety system at Company XYZ appears to be out of control. This demonstrates the need for process improvement in the reduction of occupational injuries and illnesses. Further evaluation should be considered on the various processes in place that have impacts on the current safety system performance.

- It recommended that safety performance to not be based off of incident rates. This is evident through u-chart for recordable injuries per month. It appears to have an oscillating trend, which may suggest lack of homogeneity in the reporting of recordable injuries/illnesses. Instead of basing safety system performance solely on incident rates, it is advised to use activity measures to demonstrate the safety system performance at Company XYZ. The following table demonstrates how various measures should be utilized:

Table 10
*Performance measures by organizational level**

Exhibit 6.2 Activities and results measures		
	Activity	
SUPERVISOR	**MANAGER**	**SYSTEM-WIDE**
For: Objectives Met	Objectives Met	Audit
# Inspections	Use of Media	-Questionnaires
# Quality Investigations	# Job Safety Analyses	-Interviews
# Trained	#Job Safety Observations	
# Hazard Hunts	#One-on-Ones	
# Observations	# Positive Reinforcement	
# Quality Circles	Group Involvement	
	Results	
FOR:	**MANAGERS**	**SYSTEM-WIDE**
SUPERVISORS	Safety Sampling	Safety Sampling
Safety Sampling	Inspection Results	Safety Performance Indicator
Inspection results	Safety Performance Indicator	# First Aid or Frequency
		# Near Misses or Frequency
	Estimated Costs	Property Damage
	Control Charts	Frequency-severity Index
	Property Damage	Estimated Cost Control Charts

Note. *from *Techniques of safety management: A systems approach* by D. Petersen, 2003, p.128

This assortment of measures is best utilized at the suggested levels for various benefits. Supervisors and managers have immediate impact on safety objectives met; current and leading indicators are better suited as the basis of performance measurement at these levels. System-wide performance is a compilation of all objectives met within the safety

system; lagging indicators, such as incident rates, may provide a better overview of system performance.

- Another need is to present data so everybody in the organization utilizes the information. This may be accomplished by utilizing various SPC tools and demonstrating the information through regular meetings and publications. Management may utilize the information if safety system performance is incorporated into performance appraisals.
- Finally, implement a formal safety management system that could be utilized to determine safety performance. To accomplish Objective 3: develop a process that would produce data that could be used to determine safety system performance, the following steps may be taken:
  - i) Determine a system that would best suit Company XYZ's safety system needs, such as, OSHAS 18001, OSHA VPP, and ISMEC. By utilizing a system that addresses the needs of the organization, the safety management system will be effectively utilized and integrated into the organization.
  - ii) Utilize the various elements as the basis for standards and evaluation for each individual department. These elements define various aspects that constitute the parts of the system.
    - (1) Examples may include the following:
      - (a) OSHAS 18001: Percentage of conformance to the OH&S policy, number of incident investigations, and number of safety audits completed (BSI, 2007).
      - (b) OSHA VPP: Number of equipment evaluations, number of management reviews of safety system goals and objectives, and number of new processes,

materials, or equipment reviewed to determine potential hazards (J.J. Keller, 2009).

(c) ISMEC: Number of planned inspections completed; number of safety committees supervisors and management attended, and number of drills run

iii) Measure the percentage of conformance to each standard per department. The information elicited allows an individual to know what standards are being conformed to, as well as, opportunities for improvement (Bird and Germain, 1985).

(1) Determine the quality of performance and ascribe a rating; this may be a value factor or a percentage of quality. Simply performing an activity does not mean that the activity will have a desired effect upon the safety system; by assessing quality further opportunities for improvement may be identified.

iv) Evaluate the percentage of conformance and quality for each element within the safety system.

(1) Multiply the percentage of conformance with the quality factor; this will result in the safety performance rating for the activity within the department.

(2) The information should be published as a report card at each individual entrance of the department monthly and system-wide on a quarterly basis. This may lead to an increase of accountability and employee involvement; this is further substantiated by the management axiom of "what gets measured gets done". Table 11 provides an example report card:

Table 11
Example safety performance report card

January Safety Performance Report Card						
Department	**1**	**2**	**3**	**4**	**5**	**YTD**
Inspection						
Production						
Logistics						
1. Safety committee meetings 2. Incident investigations 3. Pre-use analysis 4. Management reviews 5. On-time reporting						

(3) Statistical process controls may be utilized to evaluate the data and provide supporting evidence. Examples may include SPC charts, scatter diagrams, and Pareto diagrams. By defining standards of performance, process capability may be utilized to determine organizational and departmental safety system goals.

(4) This information then may be analyzed to set organizational and departmental goals on a regular basis.

v) Upon analysis of each department, excellent performance shall be recognized and potentially rewarded and corrective actions shall be utilized for under performance. For an effective safety management system various elements should be in place, including discipline (Williams, 2008)

vi) The performance of the safety system within each department shall be utilized within each manager' and supervisors' yearly performance appraisal to increase accountability of departmental safety performance. Eighty percent of incidents are

management controlled; by holding management accountable, incidents may be greatly reduced (Bird and Germain, 1985).

Areas of Future Study

1. Further evaluation should be considered on the various processes in place that have impacts on the current safety system performance.
2. Examine organizational loss runs from several years to better illustrate cost trends within the system.

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Appendix A: Semi-structured Interview Format

	Awareness	Problems	Suggestions
Safety system	How is your current safety system structured? Who are the individuals involved?	What are your concerns regarding safety at Company XYZ? What are some opportunities for improvement?	How could these concerns be overcome?
Safety system performance measurement	How is Company XYZ's safety system currently measured? Who utilizes the information?	What are your concerns regarding how safety performance is measured? What are some opportunities for improvement?	How could these concerns be overcome?
Safety system performance	How is your safety system currently performing?	What are some major issues in the safety system performance? What are some opportunities for improvement?	How could Company XYZ safety performance be improved?