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REDUCING ERRORS IN THE PIPELINE CONSTRUCTION INDUSTRY

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In underground construction, such as pipeline work, avoidable mistakes in the field can negatively affect the success of a project. Typical errors include installing the pipe incorrectly – the wrong grade, wrong elevation, wrong locations, etc. The only way to correct these mistakes is to excavate and remove the work and re-do it. This process usually eliminates any profit on the project or causes the project to result in a loss. The study identifies measures that contractors employ to bring awareness to human errors and mistakes before they happen and to help eliminate or reduce costly do-overs. The research reviews human behavior in the workplace, work teams, and workplace errors and mistakes in other industries such as healthcare, aviation, and manufacturing. The study methodology employed an online survey of North Carolina contractors used to measure the frequency and impact of workplace errors in the industry. The data identified led to a publish set of procedures or process changes that can potentially result in a reduction in workplace errors in pipeline construction. The study produces a better understanding of human factors in the workplace that result in errors and mistakes.

Keywords: Human factors, Human error, Communication, Costs.

1 INTRODUCTION

Underground pipelines can be expensive to build. Existing soils and groundwater conditions may require the contractor to undercut soils, dewater the excavation by well points, or excavate the trench by drilling and blasting rock materials. With these installation costs and unknown factors, it is critically important for contractors to install the work correctly the first time.

According to Rooney *et al.* (2002), human errors can be divided into two types: unintentional and intentional.

Industries mistakes in the workplace lead to learning and improved performance. Instead of assigning blame and punishing bad performers, as is typical in the construction workplace, leaders must learn to use mistakes as learning opportunities. Employees who learn from their mistakes and the mistakes of others will likely avoid the same mistake in the future.

This study addresses how contractors can reduce or eliminate human errors in the field by understanding their underlying causes and implementing preventive procedures. These changes will lead to contractors being more successful organizations in the future. By establishing the right systems and processes in underground pipeline construction, contractors can lead the way in overall quality control and profitability. In underground pipeline construction field operations, human errors result in major losses of the contractor. Thus, Establishing preventive procedures and adopting best practices in

pipeline construction can reduce or even eliminate human errors, resulting in less risk, and fewer losses and a more profitable and successful company.

2 LITERATURE REVIEW

Three important research themes will be utilized for this study. They are, 1) learning from mistakes is important and such things as "lessons learned program" and "team learning" are useful tools that could be employed in pipeline construction, 2) industry has developed ideas and tools for addressing errors and mistakes in the workplace, and 3) there are processes used in other industries that apply and benefit the construction industry.

Managers frequently do not see the "stupid mistakes" as preventable. Management can be adamant that the mistakes could not have been avoided or prevented. In the article "Learning from Mistakes" by John Davies (2004), the author argues that change in performance can only be made by challenging and ultimately changing the way managers think. There is a need to collect and use "stupid mistakes" to raise the collective awareness of the company (Davies 2004).

The collection and interpretation of minor events is a resource management should be utilizing for prevention of human error. The "what" and "why" of these events has to be collected at two levels to affect the human error problem. The first level is a description of the actions the person performed within the system. The 2nd level is the motives and intentions of the person who carried out the act or error. An attempt has to be made to find out why the person acted as they did, and then collect this information for future use (Davies 2004).

2.1 Lessons Learned Programs

Lessons Learned Programs (LLP) is defined as the knowledge gained from experience, successful or otherwise, for the purpose of improving future performance, or knowledge captured and shared to avoid recurrence. During the research review for this project, LLP emerged as a potentially important tool for implementation in the construction organization. In construction, this could consist of capturing, sharing, and utilizing knowledge of the field workforce. This information is a vital and valuable asset to any contractor. Lack of knowledge from past failures within a company should not be a cause of human error. If LLP's can be established by management, this information can become corporate knowledge for the future development of the company.

2.2 Checklists

Hales *et al.* (2006) discuss the use of checklists as a tool in human error management across fields such as aviation, aeronautics, manufacturing and healthcare. They examined how checklists contribute to reductions in the risk of costly mistakes and improving overall outcomes.

A checklist is a tool used in error management in industries such as aviation, aeronautics, manufacturing and healthcare. Checklists can provide guidance to a user and act as verification after completion of a task. The principle purpose of the checklist should be error reduction or best practice adherence. Evidence from research review indicates that checklists may reduce errors, improve safety, and improve outcomes (Hales *et al.* 2006).

2.3 Understanding Human Behavior and Human Error

There is widespread acknowledgement that human error is implicated in a major proportion of quality related costs. Most of what people do throughout the day at work follows a pattern of 1) recognition, 2) selection, and 3) action, with very little conscious thought needed. For organizational excellence, a well- informed and systematic approach to gather information about the risk of human error is necessary to avoid naïve and ineffective attempts to mitigate it (Evans 2006).

2.4 Types of Human Error

Human errors are divided into two groups, unintentional errors and intentional errors. Actions committed or omitted with no prior thought are unintentional errors. These errors, such as misreading a measurement or bumping a switch, are usually thought of as accidents. Actions deliberately committed or omitted because workers believe their actions are correct or better than the prescribed actions are considered intentional errors. For example, in manufacturing an intentional error would be when a worker skips a step in the process in order to increase productivity (Rooney *et al.* 2002).

Management decisions lead to a series of events that cause the accidents. Peter Furst writes that human error is simply a difference between an actual state and a desired state. With human error, the reasons or causes may reside with the individual or the organization's systems. He goes on to suggest two ways to prevent human error from affecting performance: stop people from making mistakes (avoidance), or keeping the mistake from impacting (interception) the system (Furst 2010). It can be said that traditional approaches to combat human error are not highly effective. The performance of individuals has to be reliable and the organizations systems must be accurately designed.

2.5 Causes of Human Error

In the article "Human Error: Myths about Mistakes", Cohen suggests that we do not have to accept human error as unavoidable. Mistakes are a reflection of the people who cause them and are not random events. The author's suggested approach is to identify and eliminate accident prone situations, not accident prone individuals (Cohen 1991).

The causes of human error in the workplace can be grouped into the following three categories:

1. Overload –The worker cannot help but make an error if given more work than he or she has the ability to handle. This overload can be physical, physiological, or psychological.

2. Decision to Error – In some situations it would be logical for a worker to choose an unsafe or erroneous act. This could be due to the worker's motivation, mental condition, or belief that he or she will not make a mistake.

3. Traps – This cause of human error involves the traps that can cause a worker to make a mistake. One trap is incompatibility, such as when working conditions are not compatible with a worker's physique or with what he or she is used to. A second trap is a workplace design that is conducive to human error.

3 METHODOLOGY

For this study methodology, a survey will be conducted of North Carolina pipeline contractors. Based on the survey results, the outcome questions of this study will be addressed and a set of best practices will be developed to help reduce or eliminate human error in pipeline construction. A survey questionnaire was developed entitled "Reducing Errors in the Pipeline Construction". The survey consisted of 23 questions created based on the literature review of human error in industry.

The first six questions (Questions 1 through 6) of the survey establish the qualifications and experience level of the survey respondents. Questions 7 through 15 were established to understand human error in pipeline construction, while questions 16 through 23 were utilized to develop best practices used in other industries. A total of 50 individuals representing 33 contractor companies in North Carolina were contacted by the author through email. Included in the email was an explanation of the research project, instructions on how to complete the survey, a deadline for completion of the survey and a link to click to go to the survey questionnaire.

4 RESULTS

The results of the first six questions (Questions 1 through 6) of the survey have established the qualifications and experience level of the survey respondents. The survey respondents consisted of contractor owners, executives, and construction managers within the industry. Over 55% of the respondent contractors have more than 20 years' experience and all of them had completed more than 20 pipeline projects. The documented experience and qualifications validate the survey results of this study.

With the results of questions 7 through 15 we have established an understanding of human error in pipeline construction. The results provide the most common human errors in pipeline construction as described by the respondents, how often these mistakes happen, and the financial and operational impacts, the types of root causes that occur with human error in pipeline construction. Most errors occur with employees with moderate or minimal experience. The most common causes of error from the survey are carelessness and lack of communication.

Finally, we have analyzed the results of questions 16 through 23. They will be utilized to develop and analyze best practices used in other industries to help prevent or eliminate human error in pipeline construction. Based on the feedback from these questions a better understanding of what contractors do within their organizations is gained. 100% of the respondents are open to trying new process changes that would help reduce or eliminate human error.

5 CONCLUSION

Considering the pipeline construction industry, human error can be categorized into unintentional and intentional groups. Using this framework of analysis, the errors identified in the pipeline construction survey fit into the same two categories:

1) carelessness and distractions would be considered unintentional errors and 2) failure to communicate effectively and a lack of knowledge or training would be intentional errors.

5.1 Unintentional Errors

Carelessness and distractions are the most common unintentional errors in pipeline construction. Thinking within the workplace is as much a part of the role of employees as is acting or doing; most of what people do at the workplace throughout the day follows this pattern. Following are two tools, checklists and training, those will aid in helping to define the outcome questions of this study.

Checklist

Checklists could be implemented to daily field operations as a tool for verification by the foreman, superintendent, or the crew leader. A checklist could be developed by the project manager for each project based on management's pre-construction review of possible human error concerns. Some projects are more difficult or complicated than others. A checklist is an important tool in error management, contributing significantly to reductions in the risk of costly mistakes and improving overall outcomes.

Training

Based on the survey results, regular training of these tasks is lacking, but was also shown to be beneficial when utilized by contractors. Training of pipeline construction should include the set-up and layout of the grade, elevations and alignment of the pipeline. This training should be provided regularly such as bi-annually or three times a year at the crew level.

If the contractor is having repeated problems with an employee in regards to human error or carelessness, there should be a best practice or policy in place to handle this situation. With regular training in place the employees should become better at the daily normal task in pipeline construction. As part of the best practices, make sure the right person is placed in the right positions in the field.

5.2 Intentional Errors

An intentional error is not intended to harm the system, but its effect on the system may be undesirable. Communication and shared learning are the focus best practices to help combat intentional errors.

Communication

Good communication begins with upper management and flows down to the crew level. If field personnel are to be great communicators, we have to begin the training and processes with our management team. Weekly toolbox talk and safety meetings are the perfect time to talk about mistakes, errors, or near misses. Based on the results, the key for these crew level meetings is the presence of upper level management such as the project manager or division manager.

Lessons Learned Program (Shared Learning)

As part of any best practices effort to reduce or eliminate human error, contractors must identify practical and effective management practices that gather information from the field personnel.

Mistakes should not be viewed as incidents to be neglected or hidden, but rather as opportunities for productive learning. Lessons learned programs involve learning through work and learning from mistakes and the characteristics of mistakes. As a best practice for underground pipeline contractors, getting feedback and communication from the field is vitally important to the processes to control human error. To establish this best practice, contractors must strategically create a culture of learning from the mistakes within the company. This workplace culture is one that is tolerant of mistakes and does not focus on concealment, but uses them as learning opportunities for the organization. Formal lessons learned program will provide the framework for such as culture.

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