Maintenance Workers Safety Study

Safety Analysis Project - Summary Report

XYZ Company* has established an effective safety program that has substantially reduced its rate of worker-related injuries. The program has focused on education and the formation of a structure that enhances the transmission of safety-related information and reinforces safety through a reward system. The effectiveness of this program could be enhanced by the development of a pre-employment assessment approach that utilizes valid predictors of work-related injury. The current research project commissioned by XYZ Company and conducted by Resource Analysis, Ltd. is part of the process of improving the ability of the railroad to meet its goal of reaching an ever increasingly higher level of safety performance.

The Safety Analysis Project (SAP) was initiated in July of 1993 and involved the assessment of maintenance workers throughout the XYZ Company system. Subjects were selected using a stratified random sample to ensure proportioned representation of workers from the entire system. Inclusion in the sample was determined by willingness to participate, the availability of supervisor ratings, and the availability of injury data. Confidentiality of results was maintained. A sample of 230 maintenance workers resulted from the selection process.

Sample

The sample was composed of 230 males, ranging in age from 22 to 64 years, with a mean of 42.2 years (SD = 9.38). The educational level of the sample averaged 11.2 years (SD = 4.38), with 56% completing high school, 8% having some post-high school education, and 36% having an eleventh grade education or less. The sample was very stable in terms of work history, with the mean number of years at XYZ Company being 17.2 years (SD= 6.36) and the median being 17.5 years. The vast majority of the sample (87%) had worked at XYZ Company for over 10 years. The data also shows that for the majority of the subjects (60%), XYZ Company was their first and only job. An additional 23% had only one job prior to working at XYZ Company. The overall picture of the sample is of middle aged, high school or less educated, individuals with highly stable work histories. The nature of the regions sampled suggest that the sample is very likely rural or small town in origin.

Safety Analysis Assessment Battery

The Safety Analysis Assessment Battery consists of a series of instruments that have been widely used in industry and transportation. The Battery included the DISC Style Analysis; the Personal Interests and Values Instrument; the Safety Analysis Questionnaire; and the SRA Pictorial and Mechanical Reasoning Tests.

The DISC Style Analysis is an instrument that assesses the individual's basic style of behavior (Basic DISC), the preferred behavioral style usually seen at home or when under a great deal of stress; the individual's behavioral response (Response DISC) to the environment; and the individual's view of the behavior required for response patterns is assessed along four dimensions; Drive (D) "how we deal with problems and challenges"; Influence (I) "How we influence and relate to others"; Steadiness (S) "how we respond to changes"; and Compliance (C) "how we react to rules and regulations."

The Personal Interests and Values Instrument is used to assess the interests, goals, and preferences that guide a person's functioning. This instrument assesses six basic values. These values include: Theoretical (Tv) "gaining of knowledge for its own sake"; Economic (Ev) "interest in gaining money"; Aesthetic (Av) "primary interest in form, harmony and enjoying life for its own sake"; Social (Sv) "interest and caring about others as a primary concern"; Political (Pv) "primary interest in power"; and Regulatory (Rv) "strong need for order."

*** Actual name of the company was not included to protect them from phone calls. Research completed by Dr. Jim Hall**

The Safety Analysis Questionnaire is a 34 item instrument that measures knowledge and beliefs about basic safety issues. This questionnaire has been widely validated in samples of factory workers and transportation workers. A high score (total possible equals 34) indicated understanding of safety-related issues, including rule following, personal responsibility, and knowledge of basic concepts in safe operations.

In addition to the style, values, and safety instruments, the SRA Pictorial and Mechanical Reasoning Tests were administered. These two tests have been used at other companies as part of their pre-employment assessment.

The supervisor of each subject was asked to complete a ten item rating form. The supervisor rated the subject's knowledge of safety procedures, along with his view of the extent to which the subject used appropriate safety measures in the workers daily functioning.

Results

The purpose of this study is to develop pre-employment screening instruments that have the ability to predict which individuals would have an increased likelihood of experiencing on-the-job injuries. Therefore, number and type of injuries was used as the primary grouping variable. Subjects were divided into groups based on injury history. Individuals who had no record of any serious or chronic work-related injuries were categorized as "non-injured." Subjects who had experienced any serious or chronic injuries were classified as "injured." The injured subjects were categorized into single serious or chronic injury group, and multiple injury group. Analysis of this categorization revealed no significant differences on any measures between these two groups of injured subjects. Therefore, in this analysis, these two subgroups were merged into a single injured group, leading to comparisons based on two groups; "Non-injured" group and "Injured" group.

The "Non-injured" group was composed of 97 individuals averaging 39.71 years of age (SD= 9.40), with an average of 11.3 years of education (SD=4.81), and an average of 14.81 (SD=8.15) years of service at XYZ Company. The "Injured" group was made up of 133 subjects averaging 43.57 years of age (SD=7.58). These individuals had an average of 11.1 years of education (SD=4.28), and an average of 18.88 years (SD=3.88) of service at XYZ Company. The "Non-injured" group was significantly younger than the "Injured" group (t=3.46, df=228,p.01). A significant difference (t=3.21, df-228, p.01) was found on total number of years at XYZ Company. A review of the data suggest that these differences may have been accounted for by the existence of a small number of outliers in the "Non-injured" sample who were significantly younger and had been at XYZ Company less than 5 years. No significant differences were found on any of the other demographic variables assessed.

It was assumed that the two groups would differ on measures of behavioral style, values, and knowledge of safety. The hypotheses were based on the assumption that these factors should all influence injury history. The following exploratory hypotheses were tested:

1. There would be a significant difference on basic style, response style, and work style between the Injured group and the Non-injured group. The specific pattern was not hypothesized.
2. There would be a significant difference on each of the values scales between the Injured and Non-injured group.
3. The Non-injured group would score significantly higher on the Safety Analysis, suggesting a relationship between knowledge and behavior.
4. Supervisors would rate the non-injured subjects as more knowledgeable about safety as measured by overall ratings.
5. Scores on SRA Pictorial and Mechanical Reasoning Tests would not be significantly different for the two groups.

Data analysis consisted of subjecting the data to multi-variant analysis of covariance (MANCOVA). This analysis was chosen to allow for the effects of the significant differences found on age and total number of years at XYZ Company to be statistically controlled. Sheffe's test, a robust post hoc test of significance of differences, was applied to determine the source of significant MANCOVAs. The p.05 level of significance was accepted as an appropriate alpha level.

MANCOVA analysis of style variables revealed a significant main effect for group (Wilks Lamba=.891, Rao's R=2.02, p.02, df=13,215). Post hoc Scheffe's tests showed significant differences for Basic D; Basic S; Response D, Response S, and Response C. Table A shows the means and standard deviate for these variables.

Table A

Means and Standard Deviations of Significant Style Differences

	Injured	Non-injured
Basic D	7.25 (SD=3.53)	8.28 (SD=3.95)
Basic S	3.91 (SD=2.40)	3.27 (SD=1.88)
Response D	3.80 (SD=2.69)	2.88 (SD=2.51)
Response S	6.74 (SD=2.85)	7.58 (SD=2.68)
Response C	4.85 (SD=2.07)	5.44 (SD=2.15)

The Scheffe's probability levels for differences between the two groups are shown in Table B.

Table B

Scheffe's Post hoc Analysis of Differences

Variable	p Level
Basic D	.05
Basic S	.005
Response D	.004
Response S	.03
Response C	.02

MANCOVA analysis of the Personal Values data revealed no significant main effect for group. Exploratory analysis of the individual values suggested a difference between the groups on Social Values (Injured M=44.95, SD=9.35; Non-injured M=47.0, SD=10.82 t=2.05, df=228 p.05), but not non any of the other value scales.

No significant difference was found for the groups on the Safety Analysis. The means and standard deviations for the two groups were: injured, M=24.22, (SD=3.71), and non-injured, M=24.15 (SD=3.10).

Analysis of the supervisor's ratings showed no group differences, either on individual items or total score (Injured 32.60 SD-11.84 and Non-injured 33.74 SD=12.09). A review of the data suggest a strong tendency toward positive ratings, regardless of injury history. There was a trend toward rating those who had worked at XYZ Company for longer periods in a slightly more positive direction.

As was hypothesized, there were no group differences on the SRA measures (Injured Pictorial M=50.87 SD=14.03, Mechanical M=38.35 SD=10.92; Non-injured Pictorial M=51.49 SD=15.34, Mechanical M=38.82 SD=9.82).

Interpretation

The differences found on the Style Analysis are suggestive of specific behavioral tendencies that may impact on safety. The score on the Basic D scale suggests that individuals who are more cautious and undemanding as part of their preferred style of behaving will be less likely to engage in behavior that could increase the probability of injury. Additionally, a basic tendency toward high levels of consistency, patience, and predictability will lend itself to taking adequate time rather than pushing oneself or acting impulsively. This is shown in the Basic S scale score. These behavioral tendencies represent the way the individual sees himself and are likely to be expressed when placed under a great deal of pressure.

The style differences found in the response to environment reflect the individual's understanding of the demands of his environment. The individual who is less likely to be injured recognizes that his environment requires an even greater tendency to be cooperative and cautious. This is especially important in a work environment where injuries are frequent and can be very severe. The low Response D reflects an awareness that the potentially threatening environment is best dealt with by exercising deliberation and caution.

The high Response S further emphasizes the perception of the environment as one in which patience and steadiness are highly adaptive. Loyalty and a team orientation are also seen as mechanisms that reduce unpredictability and threats to security in the work environment. These tendencies are further reinforced by a tendency toward compliance and rule following, as shown by the high Response C of the non-injured sample.

Style picture that describes the individual less likely to be injured is that of a basic core of Low D and High S qualities, with a shift to enhancing these tendencies in the work environment. These individuals in the work environment exhibit High C characteristics, with rule-following behavior and a team orientation.

The team orientation is further strengthened by the high social value score. This score suggest a concern for others and a tendency to define oneself in terms of the group, especially the small work unit which may serve as a primary source of identity.

This identification enhances behaviors which tend to support the group, such as rule following, compliance, and acquiescence. The high social value supports and strengthens the style tendencies of Low D, High S, and High C. This profile of Low D, High S, and High C is descriptive of the sample of maintenance workers who had not experienced serious on-the-job injuries.

The scores of the Safety Analysis exhibit no between-group differences and are within the low average score range that has been found in previous research on industrial and transportation workers. The level of the scores suggest that the educational component of the XYZ Company safety program is having an effect on workers' knowledge of safety-related factors. The response to the individual items on the Safety Analysis provides some insight into the workers' understanding of safety. As a group, the Maintenance workers tend to view the presentation of accident statistics, the viewing of the results of "horrible" accidents, and the presence of safety posters as the most effective ways to build safety attitudes. This likely reflects the workers' experience with safety programs at XYZ Company.

It appears that although these techniques are having some impact, they have not affected areas that may be more directly related to injury prevention and an understanding of the determinants of safe behavior. Respondents show a very strong tendency to emphasize experience over training as primary factors in safety. This is shown by the erroneous endorsement of answers stating that experience is more important than company policy or specific company directed training. The fact that this sample of workers have very long work histories with XYZ Company likely accounts for this tendency. However, this belief may make it very difficult to develop new, safer work habits and should be a concern for the safety program.

Further influencing the training of safer work habits is the tendency of the respondents to endorse items that reduce personal responsibility for accidents and do not recognize the relationship between personal attitudes and on-the-job safety behavior. These views need to be considered when developing training programs so that these issues are directly addressed.

The lack of group differences on the supervisor's ratings reinforces previous research which has found that supervisors do not make distinctions based on performance such as knowledge of safety or safe behavior. Rather, they tend to base ratings on factors not usually assessed by behaviorally based ratings such as liking and perceived similarity to the supervisor.

The lack of group differences on the SRA measures was expected in that they are not conceptually tied closely to safety-related issues, especially at the Maintenance worker's level. Although these measures have some utility in assessing basic intellectual functioning and flexibility, they are not helpful in differentiating injured from non-injured workers.

Recommendations

Analysis of the data suggest a number of recommendations that may enhance the safety program at XYZ Company.

1. The use of the DISC Style Analysis and Personal Values as components of XYZ Company's applicant screening process. The data presented strongly suggest a profile that is related to increased level of safety. it is recommended that a goodness of fit approach be used in screening applicants so that those who most fit the profile derived in this study would receive a positive weighted score that would be added to previous job history, performance on tests of mechanical flexibility and problem solving, and recommendations. Scores on the DISC Style Analysis and Personal Values scale would serve as positive inclusionary rather than exclusionary criteria.

2. The use of the Safety Analysis as a tool to assist in the development of training programs that help train workers in appropriate safety techniques. The Safety Analysis would serve as a useful pre/post-test measure of learning in the Safety Program.

3. The data gathered in this study suggest avenues to explore to further develop the existing safety program. Among the suggested changes are an increase in the use of direct training techniques such as job-related training where direct modeling of appropriate safe behavior is conducted with immediate feedback and reinforcement. An example would be a lifting module where appropriate lifting techniques are modeled with opportunities for the trainee to engage in the behavior, with corrective feedback and reinforcement. This active approach would be used along with the passive techniques of files, booklets, and posters.

4. The use of reinforcement of safe behavior, based on the performance of both individuals and small work groups. The emphasis on group performance may be used to enhance group identification and concern for other workers of their small work group. The reinforcements need to be relevant,immediate, and tangible. (For example: quarterly, group=based bonuses, if allowed by contract.)

5. The training of supervisors in recognition and evaluation of safety-related behaviors. There is a need to have objective standards of evaluation to provide valid feedback to the workers.

6. The continuation of data-based assessment of each functional level at XYZ Company to develop assessment and training strategies that are specific to the nature of the job rather than general and generic.