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Fall Protection Incentives in the Construction Industry: Literature Review and Field Study

Gary L. Winn
West Virginia University, Morgantown, USA

Brian Seaman
Kinder Morgan Materials Service, Pittsburgh, PA, USA

John C. Baldwin
West Virginia University, Morgantown, USA

Safety literature confirms that incentives such as money or sunglasses seem to improve safety conditions over the short run. However, no studies could be found which tested the effect of incentives on fall protection for a period longer than a few days.

In our research we found that after 6 months, the use of non-material incentives significantly improved on-time delivery and completion rates of a special inspection form (both p < .005). In addition, a questionnaire with embedded critical questions showed that even though workers said that they preferred material incentives, we conclude that their behavior was changed by the treatment (incentives). We further conclude that the use of natural reinforcers seems to influence worker behaviors and perception of management's commitment to safety over the long run, even though workers still say that they prefer tangible rewards. Future work should replicate these findings and explore why workers respond to natural incentives but express a preference for material incentives

fall protection construction incentives field test

1. INTRODUCTION

Approximately one third of all construction-related deaths are the result of falls from elevations and the majority of long-term disabling injuries is the result of such falls. The U.S. Department of Labor, Bureau of Labor Statistics, reports that in 2000 the construction industry had 1,154 fatalities [1]. Within this total, 734 were the result of falls, or roughly 64% resulted in the loss of life from falls from elevations.

Construction-industry falls have been a top priority of the Occupational Safety and Health Administration (OSHA) [2] since 1994 and remain so today. Reducing fall-risk to workers is a high priority of many companies in the USA engaged in construction, so that sometimes incentives are offered to increase rates of compliance and the reduction of at-risk behaviors.

Our literature review determined that incentives in the construction industry fall into two categories. Material incentives are defined as money or durable goods which have intrinsic value to employees. Material rewards include cash, hats, sunglasses, pocket knives and similar goods. One study demonstrated the effectiveness of using a cash incentive which, over the short run, increased the use of safety belts in elevated work [3]. These authors reported that belt use actually declined after the incentive contest was completed and the incentive was withdrawn, but the final level of belt use was still significantly higher than baseline scores.

Correspondence and requests for offprints should be sent to Gary L. Winn, Industrial and Management Systems Engineering, P.O. Box 6070, West Virginia University, Morgantown, WV 26506-6070, USA. E-mail: <gwinn@wvu.edu>.

Natural incentives, which we have defined as non-durable behavior reinforcers, are also used to modify employee safety behaviors. Natural reinforcers include the use of performance feedback (coaching, for example) to reinforce appropriate behavior, but these can also include employee-determined work schedules, and independent work resulting in less frequent visits by the safety manager so long as safe behavior continues. Performance feedback about individual employee safety performance indicates an effective alternative to the use of disciplinary action or rewards to encourage compliance with safety rules [4]. Hale and Glendon [5] assigned more responsibility and changed the workers' task to get a desired improvement in this study of natural incentives; their findings were in the expected direction but tested only over the short period.

Support for incentives generally is found in a review of selected literature by McAfee and Winn [6], which revealed almost without exception that incentives or performance feedback enhanced safety and/or reduced accidents in the workplace. Eisenberger [7] found that a significant relationship exists between the favorableness of job conditions believed to be controlled by their employer and the conditions which the employee had direct control over. Another recent review by Lingard and Rowlinson [8] provides support for material incentives used in conjunction with feedback to increase the overall effectiveness of safety performance. All of these effects were observed for the short term, usually days or a few weeks. In the construction industry, Austin, Kessler, Riccobono, and Baily [9], who used small tangible reinforcers such as cold drinks and fruit to enhance the safety program on roofing crews, found that the program made workers more aware of the safety program.

The behavioral theory of worker safety relies on the general notion that reinforcers alter the frequency of the behavior, thus shaping it. These models consider that positive reinforcers increase the frequency of the desired behavior, whether the incentive is material or natural. However, some safety theorists suggest that material reinforcers such as sunglasses or money are often accompanied by unexpected negative outcomes such as hiding injuries in order to maintain the tangible reward, and the authors note that the desired behavior often disappears with the removal of the material reward [10]. These authors suggest that natural reinforcers are more stable and have fewer negative correlates than material rewards and this is the direction we chose to investigate in the study outlined here. The Cope et al. study [3] mentioned earlier seems to validate this concern because the desired behavior, safety belt use, decreased when the material reward was withdrawn.

Our review of literature revealed that while material incentives have some positive benefits in the construction industry, there is no mention of the potential drawbacks such as hiding injuries to maintain the reward. On the other hand, natural incentives may overcome some of the drawbacks, but they have not been widely tested over the long period.

2. THE CURRENT STUDY

Among fall hazards generally, improper use of scaffolds have been among the most frequently cited OSHA standards for the whole decade of the 1990s continuing even into 2002. OSHA has found the use of scaffolds to be particularly hazardous over the years because workers often fail to install full cross-bracing, or fail to provide sufficient ground foundation. Workers will also often fail to add the required guardrail at working levels. Any of these can result in falls from elevation. With any scaffold use, OSHA has established mandatory inspection requirements by qualified personnel in order to help assure proper use of scaffolds and, in turn, reduce fall hazards. In the current study at a building construction site in Baltimore, MD (USA), we wanted to know whether fall hazards associated with scaffold use could be reduced by using incentives.

The construction company sponsoring this study had purchased a few sets of specialized scaffolds made by the HEK Company (USA) because they are constructed with integral guardrails and do not need cross-bracing because the HEK climbing platform is to be lowered from the top of the building and, as such, it does not require foundations and mudsills. Figures 1–3

Figure 1. A HEK (USA) climbing platform, manufactured to eliminate difficulties with scaffold footing, removable guardrails, and variable cross bracing.

Figure 2. A HEK (USA) climbing platform at about 30 feet (10 m) vertical height. *Notes*. Brick cut-out for fastening to wall. Brick will be replaced as final operation before removal of platform.

depict the HEK climbing platform in use in the Baltimore, MD, area in 2002 at the time of this study.

Because of the HEK design improvements, company management wanted to abandon the use of traditional scaffold and purchase more HEK climbing platforms, but it needed to know if the HEK climbing platforms would as economical

Figure 3. A HEK (USA) climbing platform at about 20 feet (7 m) vertical distance with workers on board.

and safe to use as traditional end-frame or tube-and-coupler scaffolding. To ensure that safety or design deficiencies, if any, were discovered before the company spent money on more HEK climbing platforms, the management wanted to gather inspection data. The safety manager proposed to inspect the new HEK climbing platform in the same manner as the company did any other scaffold. To ensure that it got the most complete and on-time inspection data possible, the safety manager proposed incentives to inspectors to measure whether inspections were improved over the long term. The natural incentive proposed was the inspector working almost independently. No monetary or material incentives were used.

Low-seniority crafts-level workers did not inspect scaffolds at the site of this study. At this site, shift foremen and senior-level crafts people usually performed the scaffold inspections. Yet, even under good conditions, the inspection forms were sometimes delayed getting to maintenance personnel in charge of correcting scaffold problems and sometimes the forms were incomplete, which made the inspection useless. Baseline scaffold inspection rates were not very good at 60% on-time delivery and 75% completion. Improving these rates became the main focal point of Part 1 of this study, testing whether a sample of 30 current scaffold inspectors would improve their base rates of timeliness and completion of inspection forms after 6 months of the incentive.

In informal terms, we proposed that inspection forms for the HEK scaffold would be more complete and delivered on time in the presence of natural incentives compared to current rates of completion and delivery without incentives. Second, we proposed that after 6 months workers would maintain improved scaffold inspection rates, favor the use of natural incentives over material incentives, prefer to work independently, prefer to have more involvement in their own safety program, and feel that company management was fully committed to safety.

2.1. Treatment and Operant Definitions

The treatment can be operantly defined as the presence of performance feedback and independent work being used to improve base rates of frequency and completion rates observed at 60 and 75% respectively. Performance feedback means that the safety manager would make a point of passing by the workplace twice per day where the work platform was being used and speak with the foreman and workers about any maintenance problems with the platform that might have been identified. The safety manager would periodically also thank the shift workers for helping collect inspection data on the new climbing platform. Independent inspections means that, once trained in inspection protocols by the vendor of the work platform and having passed a written test on the platform, the workers would function independent of the safety manager who would normally conduct these fall-equipment inspections. Workers would identify hazardous conditions on a standard inspection sheet and submit the sheets to the carpenters who performed maintenance and repairs. Workers did not need to wait to consult with the safety manager to correct a hazardous condition. Commitment to safety is defined as results of four questions in an anonymous, voluntary survey of 10 questions (QE1–QE4) which probed whether subjects felt management was committed to worker safety. The survey was delivered after 6 months after beginning the study.

2.2. Null Hypotheses

The null hypothesis, H_0, in Part 1 of the study is that natural incentives (performance feedback and independent work) would not influence company inspectors to complete scaffold inspection forms on time (OT) and more fully completed (FC) compared to base rates of 60 and 75% respectively after a 7-week test period. The alternate hypothesis, H_1, suggests that these base rates would significantly improve after the test period.

On-time inspection form delivery (OT) can be expressed in the null form as:

$$H_0: u_{1\,(OT)} = u_{2\,(OT)},$$
$$H_1: u_{1\,(OT)} \neq u_{2\,(OT)}.$$

Similarly, inspection form completion (FC) can be expressed in the null form as:

$$H_0: u_{1\,(FC)} = u_{2\,(FC)},$$
$$H_1: u_{1\,(FC)} \neq u_{2\,(FC)}.$$

After 6 months in Part 2 of the study, we hypothesized that a sample of all company workers at this site would judge management's commitment to safety to be positive as measured on four questions embedded (QE1, QE2, QE3, and QE4) in a 10-item questionnaire. In null form, the mean responses on QE1–4 would exceed 50% favorable responses:

$$H_0: u_{(QE1\text{–}4)} \leq .5,$$
$$H_1: u_{(QE1\text{–}4)} > .5.$$

2.3. Study Design

The study was a single-group, within-subjects design with subjects serving as their own controls. There was no formal control group employed.

2.4. Dependent Variable

In Part 1, the dependent (measured) variable was the on-time percentage of the new inspection forms being submitted, that is, the form was submitted to maintenance within a half-hour of the start of the shift. Any form delivered beyond the half-hour window was considered late. A completed form was determined to be a form with more that 90% of the inspections filled in. Any form less than 90% complete was considered incomplete. In Part 2, the dependent variable was the direction and degree of approval of the safety commitment to safety based on the 4 embedded questions in a survey of 10 questions related to perceptions of the company's safety program.

2.5. Subjects and Subject Selection

In Part 1, 30 senior workers and foremen on dayshift composed a sample of volunteers to perform HEK inspections. Average age was 32.5 years, and average experience in construction was 8 years. All were males in generally good health. Company policy was to update fall hazard training annually; all subjects had undergone this training. Subjects underwent a training class developed by the HEK climbing platform manufacturer and successfully passed HEK's test on inspecting the platform for fall hazards. Subjects were not informed about the study regarding incentives as a treatment, but subjects were aware that they were helping evaluate the inspection form itself in anticipation of the purchase of additional HEP climbing platforms.

2.6. Instructions to Subjects

The subjects in the study were considered partners in the process and not mislead at any time. Inspectors were instructed to use the standard inspection sheet at the start of each shift and on which they could note deficiencies with railing, motors, anchorages, and so forth, and to submit the form in the same manner as if they were using traditional scaffolds.

2.7. Limitations of the Study

Our design did not include a separate control group. Subjects in the pre-treatment period were the same subjects as in the treatment period and thus served as their own controls. Second, because volunteers were used as subjects, our conclusions could be a result of the Hawthorne Effect in which workers are pleased to get attention from management and respond by behaving to please management [11]. Third, delivery of performance feedback was not operational; that is, its content and frequency was not measured or made consistent in any meaningful way outside of frequency (twice per day).

2.8. Research Results

In Part 1, longitudinal data were compared to base rates (OT: 60% and FC: 75 respectively). A statistical test of proportions was performed on each data set (OT and FC) and *z* scores were derived for each set according to the following formula [12]:

$$z = \frac{(\hat{P}_1 - \hat{P}_2)}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad \text{where } \hat{p} = \frac{(x_1 - x_2)}{n_1 + n_2},$$

z is the observed z value,
$\hat{P}_1$ is the observed value for proportion before treatment,
$\hat{P}_2$ is the observed value for proportion after treatment, q is $(1 - p)$,
$\hat{P}$ is the estimate of the true value of the proportion,
n_1 is the number of observations before treatment,
n_2 is the number of observations after treatment,
x_1 is the number of successes of the treatment,
x_2 is the number of non-successes of the treatment.

After 6 months, on-time (OT) inspection form rates of 90% were seen to have improved significantly ($p < .005$) . Forms completed (FC) rates of 95% after 6 months were seen to have improved significantly ($p < .005$).

In Part 2, 29 out of 32 possible anonymous surveys delivered to the crafts people were returned for analysis for a response rate of 90.6%. Four questions about incentives had been embedded (randomly distributed) inside of the 10-question survey. The 6 questions which were unrelated to incentives and unrelated to perceptions of management commitment to safety were not analyzed. The first embedded question (QE1) related to whether workers favored material or natural incentives. Sixty-six per cent of the respondents favored the use of money in the future as a reward for helping develop the inspection form which would be used when the company purchased new HEK climbing platforms. In the second embedded question (QE2) asking about how workers felt about performing their own inspections of the HEK platform, 81% of the respondents said they preferred doing independent inspections of the platform.

In embedded question 3 (QE3), workers were asked if they wanted to be even more involved in safety inspections that they had been in the past, and 91% responded that they wanted more involvement. In the final embedded question (QE4), fully 88% of respondents said that they felt management was fully committed to reducing fall hazards.

Each of these questions significantly exceed ($p < .010$) the hypothesized level of 50% and were judged to be accurate indicators of worker satisfaction with the safety program.

2.9. Conclusions and Discussion

There was some discussion among inspectors that suggested they did not understand how to complete the form even after HEK training but because the safety manager identified and then corrected the training deficiency sometime in week 2, researchers did not feel this was enough of a problem to constitute a serious confound. Indeed, the researchers concluded that natural reinforcers (performance feedback and independent inspections) significantly influenced timeliness and completion of inspection forms which in turn reduced fall hazards presented to workers using the scaffolds.

In Part 2 of the study, workers seemed to appreciate management trying to reduce fall hazards, they wanted to work independently and perform their own inspections and they preferred material incentives (money) despite the fact that the study used natural incentives and not material incentives. The crafts people in the study sample actually improved their behavior in response to natural incentives.

The researchers conclude that natural reinforcers have a place in fall protection and that future studies should capitalize on this work. Further study of different natural incentives in fall protection and over a similarly long trial period seems warranted.

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