Effective Intervention Strategy to Improve Worker Readiness to Adopt Ventilated Tools

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Abstract: An effective theory-based intervention strategy is developed to improve worker adoption of a ventilated dust-control tool that reduces dust exposure by 95%. The Prevention through Design Adoption Readiness Model (PtD ARM) was employed to develop educational materials, hands-on training, and worksite cues-to-action. Educational materials were targeted to improve worker knowledge of the health risks associated with construction dusts. Hands-on training was developed with the objective of improving worker self-efficacy regarding the new equipment. Additionally cues-to-action were given to the workers. These cues were hard-hat stickers and *t*-shirts with reminder slogans. In a pretest/posttest experimental design with control group ($n = 40$), questionnaire data were analyzed using independent *t*-tests of the gain-scores, and significant changes ($p < 0.05$) were seen in worker self-efficacy, trust-in-technology, and overall readiness to adopt the tool. Theory-based intervention strategies were found to be effective in improving worker willingness to use ventilated tools. The most impactful intervention methods include training regarding risks to worker health, hands-on training with ventilated tools, and cues-to-action reminders to use the tools. **DOI:** 10.1061/(ASCE)CO.1943-7862.0001123. *© 2016 American Society of Civil Engineers.*

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Introduction

Overview

Drywall-finishing operations are associated with worker overexposure to mineral dusts that have negative impacts on health. Ventilated tools have been found to reduce worker dust exposures; however, adoption of these tools in industry is not widespread. Therefore, this paper describes a theory-based intervention strategy to improve adoption of ventilated drywall sanding tools by drywall-finishing workers. This project was part of a larger body of work in which a theory-based conceptual model, the Prevention through Design Adoption Readiness Model was formulated (Weidman et al. 2015b) and model-based interventions to improve tool adoption were developed for three target populations: construction workers, owners of small construction firms (Weidman et al. 2015a), and purchasing agents in large construction firms (Weidman et al. 2015c). These three populations were of interest because previous research (Young-Corbett and Nussbaum 2009b) had indicated that barriers to innovation adoption differ among these groups. This paper describes the model-based intervention for the worker population.

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Health Hazards of Drywall Dust

Drywall-finishing operations have been associated with worker overexposure to dust that contains known particulate respiratory-health hazards. The National Institute for Occupational Safety and Health (NIOSH) conducted an evaluation of worker exposure to drywall dust and potential health effects associated with drywall-finishing work during renovation activities (Miller et al. 1997). This study of workers performing drywall-sanding tasks evaluated the main constituents of drywall-joint compound, worker respiratory symptoms, and dust-exposure levels. Drywall finishers were exposed to as much as 10 times the permissible exposure limit (PEL) of 15 mg/m^3 for total dust. The PEL for respirable dust (5 mg/m^3) was also exceeded. Respiratory symptoms were found to be common among drywall finishers and tended to improve when workers were away from the workplace. Joint-compound constituents were identified as calcite, quartz (silica), talc, mica, gypsum, clays (aatpulgite and kaolinite), and perlite, with the two most prevalent constituents being calcite and mica. The term mica refers to a family of minerals of similar chemical composition and physical properties. They are potassium aluminum silicates with variable amounts of iron and magnesium. Mica has been associated with pneumoconiosis (Verma et al. 2003). Calcite, a form of calcium carbonate (CaCO3) found in limestone, chalk, and marble, has been implicated in airway obstruction (Bohadana et al. 1996). Bohadana found a significant across-shift decline in all parameters associated with airway obstruction in chalk-powder (calcite) manufacturing workers. Calcite exposure levels correlated with airway function decrement. Quartz (crystalline silica) has well-documented effects on the human respiratory system and has been associated with silicosis, a fibrotic disease of the lung, and malignant neoplasm of the lung (Mead and Miller 2000). The International Agency for Research on Cancer (IARC) has classified quartz as a Group I Human Carcinogen, a classification indicating that sufficient evidence of causality exists in the scientific literature (IARC 2000).

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Ventilated Construction Tools

A National Institute for Occupational Safety and Health (NIOSH) Hazard Control Study found that ventilated sanding systems reduce drywall dust levels by 80 to 97% (Mead and Miller 2000). This evaluation of five commercially available ventilated drywall-sanding systems found that four of the five systems reduced dust concentrations by more than 90%. A study of the relative dust-control effectiveness of drywall-sanding technologies found that ventilated sanders produced significantly less dust of both respirable and thoracic size classes than did the conventional block sander (Young-Corbett and Nussbaum 2009a). The ventilated tool reduced respirable concentrations by 88% and thoracic concentrations by 85%. Despite the existence of dust-control technologies for the mitigation of this hazard, worker exposures to dust persist in the drywall-finishing industry (Mead and Miller 2000). A survey of owners of drywall-finishing contracting firms revealed that ventilated sanders, low-dust joint compounds, and wet methods are not employed by most workers (Young-Corbett and Nussbaum 2009b).

Barriers to Adoption

In a study of technology-adoption barriers from the worker perspective, drywall-finishing workers participated in semistructured, in-depth personal interviews (Young-Corbett et al. 2010). Attitudes and perceptions toward dust-control technologies were solicited and emergent themes were explored. The Health Belief Model (HBM) served as the framework for understanding workers' readiness to adopt control technology. Workers tended to perceive a risk to health associated with the dust; however, assessments of personal susceptibility to disease were low. Identified barriers to adoption were organizational factors and self-efficacy. The participants expressed little confidence that management would value worker health and reported a perception of having little personal control over the decision to adopt this technology.

Adoption Readiness has been defined as a "state-of-mind about the need for an innovation and the capacity to undertake technology transfer" in a comprehensive review of the literature on the subject (Armenakis et al. 1993). It is the cognitive precursor to "behaviors of support" for the actual transfer effort. Individual and organizational readiness for change are said to involve beliefs, attitudes, and intentions regarding (1) the extent to which changes are needed, and (2) the level of capacity available to make the requisite changes. Adoption readiness is the first phase in the Natural Cycle of Change model advanced by Lewin (1947). Defining readiness for change in this way has two important implications for the design and implementation of technology-transfer interventions: readiness can be enhanced, and it can be assessed (Kanter 1983). Readiness for change is not a fixed element of individuals or systems. It may vary due to changing external or internal circumstances, the type of change being introduced, or the characteristics of potential adopters and change agents. Thus, interventions to enhance readiness are possible and can increase the overall success of technology transfer (Backer et al. 1995).

Theory-Based Intervention Strategy

Because the adoption of ventilated sanding tools involves adoption of an innovative *technology* for the purpose of preventing a *health* outcome, a conceptual model that weaves together constructs pertinent to technology adoption and health-behavior change was employed as the theoretical framework for the intervention strategy described in this paper. The conceptual framework for the Prevention through Design Adoption Readiness Model (PtD ARM) (Weidman et al. 2015b) integrates elements of three previously validated frameworks: the Technology Acceptance Model (TAM) (Davis 1989), the Health Belief Model (HBM) (Rosenstock 1960), and the Diffusion of Innovation Model (DOI) (Rogers 2004).

The Technology Acceptance Model (TAM) was developed by Davis (1989) to explain the factors that influence the decisions to accept or use new technology (Venkatesh 2000). The TAM was originally designed to understand and predict user intentions to accept new computer technologies but has been used to understand technology acceptance in various fields of study including medical technology, communication systems, and information technology (Hu 1999; Chau 1996; Venkatesh 2000; Brown 2002; Yi et al. 2006). The TAM has been used to show that prospective adopters' behavioral intentions to use a technology correlate to the actual usage of the technology (Chau 1996). If potential users do not fully accept the new technology, they can obstruct the new system and cause it to be underutilized (Brown 2002). The TAM is comprised of two main constructs: perceived usefulness (PU) and perceived ease of use (PEOU) (Davis 1989).

The Health Belief Model (HBM) was developed to explain the decision processes related to actions people take to prevent injury or illness (Rosenstock 1960). For decades, the HBM has been one of the most widely used theoretical constructs used in studying health behaviors. It has been used to explain both adoption and adherence of health behaviors and the continued following of health behaviors (Young-Corbett and Kleiner 2008). This model focuses on perceptions, beliefs, and other personal characteristics that influence whether a person feels at risk for a certain health problem and whether they position themselves to change certain health behaviors, health practices, and/or to utilize healthcare services (Lux 1994). Individuals who value the perceived benefits of behavioral changes will attempt to change as long as they believe their current behavior poses a threat to their lifestyle and if they feel they are capable of adopting the new behavior (Rosenstock 1960).

An innovation could be any idea, product, process, or object that is perceived as new to an individual or group (Rogers 2004). Diffusion of innovation is the process through which an innovation, whether an idea or product, is communicated over a period of time in a social system and involves some degree of uncertainty (Rogers 2004). Innovation is defined as a significant improvement in a product, process, or system that is actually used and which is new to those who will be developing or using it (Manseau and Shields 2005). One of the necessary components of an innovation is the ability of the innovation to improve some aspect of the adopter's performance of a work task (Toole 1998). Two important factors that are involved in the diffusion of innovation are the innovation's discovery and its diffusion (Ball 1999). Diffusion involves communication about the innovation to the target adopters (Koebel 1999). Four main elements compose the general diffusion model as outlined in the 5th edition of *Diffusion of innovations* (Rogers 2004) include the innovation, communication channels, time, and a social system. The construction industry has been viewed as an industry that is resistant to technology and slow to adopt new innovations (Koebel 1999). The importance of innovation in the construction industry is recognized as a means to improve worker quality of life, productivity, and safety (Arditi et al. 1997).

Occupational Health and Safety Intervention Design Research

In a review of methodological criteria for evaluating occupational health and safety (OHS) interventions, Shannon et al. (1999) state the need for additional empirical evaluation of theory-based interventions. The authors conclude that a "definite need for safety researchers to increase their efforts in evaluating the effectiveness of interventions" exists and should be addressed by the OHS academic community. These authors proceed to describe criteria for the design of effective empirical evaluations of OHS interventions: (1) clear objectives, (2) experimental or quasi-experimental design, (3) external validity, (4) internal validity, (5) statistical analysis, and (6) conclusions that address the objectives. Therefore, the current study was designed to adhere to all of these methodological recommendations. Regarding specific strategies that interventions employ to improve OHS performance, Hale et al. (2010) state that there is "relatively sparse literature on the effectiveness of . . . intervention to improve safety performance." These authors found that educational and learning strategies, as well as communication among managers and workers, were among the most successful intervention techniques. Champoux and Brun (2003) conducted telephone interviews with owners and managers in small firms to identify barriers to OHS performance and found that a lack of education about risks and controls was a key factor. The authors suggest that educational intervention strategies might, therefore, be fruitful avenues of OHS intervention research. A recent conceptual model was developed to describe the interplay among external stakeholders, intervention strategies, and workplace contextual factors (Baril-Gingras et al. 2006). This study found that the most successful intervention strategies, as measured by proportion of implementation, involved worker training. Specifically, training in which workers had a chance to practice the behaviors of interest was most successful. Based on this prior work in OHS intervention development and evaluation, the current project designed intervention strategies that emphasize worker training, which include hands-on elements as well as information.

Methods

Intervention Design

An intervention strategy was designed based upon the PtD ARM constructs of relevance to the worker stakeholder group within the construction industry. Thus, the intervention aimed at improving the following constructs in relation to worker safety and health: perceived risk of drywall dust to personal health, health knowledge about the effects of drywall dust, trust in organization, trust in technology, and self-efficacy. Influencing these antecedent constructs, it was hypothesized, would influence overall readiness to adopt the technology. In order to target these model constructs, the intervention strategy was composed of three elements: training, cues to action, and trial-ability.

Training Component

In a systematic review of the effectiveness of occupational safety and health training on worker well-being, Robson et al. found strong evidence for the effectiveness of training on worker OHS behaviors (Robson et al. 2012). Therefore, the intervention design included a combination of didactic and interactive training. A training presentation program was developed that included information about the material composition of drywall dust, the health effects of dust exposure, and the usefulness and relative advantage of ventilated sanders. These targeted the model constructs of health knowledge, perceived health risk, and trust in technology, respectively. The intervention training sessions were held at the jobsites where the employees were working in order to allow for real-world demonstration and to minimize disruption. Training sessions were conducted by an authorized OSHA outreach trainer with experience in teaching construction-safety topics. The training was worker-centered (Hale et al. 2010). Interactive small-group training was used, as this method has been strongly associated with achieving desired changes in work practices (Champoux and Brum 2003). All workers received a certificate of training to acknowledge they had received health and safety training from the OSHA-authorized trainer. This certificate was aimed to enhance the credibility and perceived value of the training.

Cues to Action

Two cues to action were developed as part of the intervention strategy (Fig. 1). Cues to action are prompts that remind workers to take action or to practice certain behaviors that will protect their health. Effective cues are integrated into the everyday work environment and are readily visible and eye-catching (Baril-Gingas et al. 2006). Cues that workers can see regularly are used so the behavior could be reinforced often. The intervention strategy incorporated two cues to action: hard-hat stickers and *t*-shirts. Both stickers and shirts bore the project slogan: *SUCK IT UP! Don't let drywall dust affect your health, now or later*. The *t*-shirts and stickers were given to the workers to wear regularly to remind them and their coworkers of the hazards associated with drywall dust exposure and the

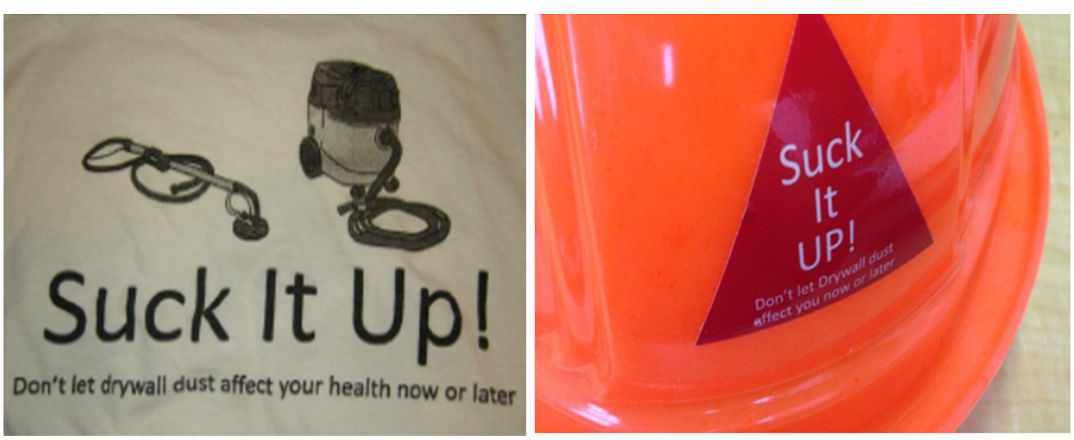

Fig. 1. Worker cues to action (t-shirt and hard-hat sticker)

importance of using dust-control technology to protect them from overexposure to dust.

Trial-Ability

Along with health and technology information, workers received a hands-on, experiential training with the ventilated sander. This strategy was designed to provide *trial-ability* and aimed at improving worker self-efficacy and trust in technology. Trial-ability is a construct that originated in the Technology Acceptance Model (TAM) and is directly related to the self-efficacy construct of the Health Belief Model (HBM) (Robson et al. 2012). It is defined as the extent to which consumers have the ability to try and test the new technology. The more someone understands how a technology works, the more likely they are to trust the technology (Becker 2004). This hands-on training allowed workers to empirically learn the function, mechanism, and operation of the tool.

Data Collection

Survey Instrument

Data for the study were collected utilizing a previously validated survey instrument (Weidman et al. 2015b), with versions in English and Spanish. The instrument contained 22 scaled items pertaining to PtD ARM model constructs. Each scaled item was scored as a seven-point Likert Scale with the following scale: 1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neither disagree nor agree; 5 = somewhat agree; 6 = agree; and 7 = strongly agree. For a detailed description of the survey instrument, scaled items, and validation process, the reader is referred to Weidman et al. (2015b). For the intervention group ($n = 20$), data were collected at initial time of contact (Pretest), immediately following the intervention (Posttest 1), and 3 months following the intervention (Posttest 2). For the control group ($n = 20$), data were collected at the initial time of contact (Pretest), one day following (Posttest 1), and 3 months following (Posttest 2) initial contact. The statistic of interest was the gain score, which is defined as posttest score minus pretest score.

Power Analysis

A minimum sample size of 17 per treatment group was determined through power analysis for a two-group independent *t*-test, with an expected difference in gain score of 1.0, an alpha of 0.05, a power of 0.80, and a standard deviation of 0.5. The expected difference in gain score was based on prior work on the subjects of pretest posttest experimental designs and measurement of change using gain-score analysis for seven-item Likert Scales (Dimitrov and Rumrill 2003).

Participants

Participants ($n = 40$) were drywall-finishing workers recruited from a convenience population in Virginia and North Carolina. Workers were recruited by networking through drywall supply companies in Virginia and North Carolina. All participants were male. Forty percent of the participants identified as Latino and 60% as non-Latino, numbers that reflect the demographics of this trade in this geographic region. Participants work groups were randomly assigned to control and intervention groups. Intact work groups were not divided into treatment groups to ensure that intervention strategies were not influencing control participants. All were compensated in the amount of $15.00 per hour for their participation. All methods were approved by Virginia Tech (Blacksburg, Virginia).

Experimental Methods

Researchers visited work groups and followed standard experimental protocols. Each session began with informed consent. Pretest survey data were collected next. For the intervention groups, this was followed with training, cues-to-action, and trial-ability sessions. The ordering of these intervention components was held constant across all trials. Once the interventions were complete, the participants were then given the Posttest 1 survey. Control group participants completed Posttest 1 on the day following the pretest. Three months following the pretest and intervention sessions, work groups were again visited by the research team and data for Posttest 2 were collected.

Data Analysis

Scaled survey items were analyzed using one-tailed, independent *t*-test on the gain scores to test for differences in control and intervention groups. All statistical analyses were performed using *JMP 9.0.0*.

Results

As summarized subsequently (Table 1), significant differences in gain scores between intervention and control groups were seen for the following constructs: self-efficacy, trust in technology, and adoption readiness. Interestingly, for adoption readiness, the intervention group's gain score was highly significantly different from that of the control group in Posttest 1. However, by Posttest 2, there were no significant differences between the groups regarding adoption readiness. There were no significant improvements in intervention group scores on the health knowledge, perceived risk to health, or trust in organization constructs when compared to those of the control group.

Discussion

The findings of this work yield contributions to the body of literature on intervention research in occupational health. Goldenhar and Schulte (1996) reviewed the state of the literature from 1988 to 1993 and called for an increase in methodologically rigorous studies of occupational-health intervention effectiveness. These authors called for an increase in theory-based intervention studies. In borrowing well-established theoretical frameworks from the related fields of health promotion and technology market diffusion, the present study allows for an analysis of the intervening and mediating variables impacting intervention effectiveness. In 1996, Goldenhar and Schulte (1996) recommended that occupational-health intervention studies be conducted by multidisciplinary research teams in order to facilitate the development of interventions that address many dimensions of the work system: organizational, behavioral, and technological. A multidisciplinary research team developed the Prevention through Design Adoption Readiness Model (PtD ARM), which served as the theoretical foundation for the intervention study described here. This team was composed of researchers with expertise in health promotion, industrial hygiene, building construction, and marketing of technological innovation. This multiperspective approach to intervention design allowed for consideration of all aspects of the drywall sociotechnical work system.

Table 1. Results of Independent One-Tailed t-Test of Gain Scores

Construct	df	Mean	Standard error	p-value	Significance
Health knowledge Posttest 1					
Control	18	1.44	0.61	0.49	—
Intervention	20	1.45	0.45	—	—
Health knowledge Posttest 2					
Control	18	1.44	0.63	0.58	—
Intervention	20	1.25	0.60	—	—
Self-efficacy Posttest 1					
Control	18	−0.11	0.88	0.05	a
Intervention	20	1.73	0.65	—	—
Self-efficacy Posttest 2					
Control	18	−0.11	0.73	0.03	b
Intervention	20	1.95	0.69	—	—
Perceived risk to health Posttest 1					
Control	18	1.22	0.71	0.31	—
Intervention	20	1.67	0.53	—	—
Perceived risk to health Posttest 2					
Control	18	1.22	0.60	0.30	—
Intervention	20	1.65	0.57	—	—
Trust in technology Posttest 1					
Control	18	0.55	0.82	0.02	b
Intervention	20	2.60	0.60	—	—
Trust in technology Posttest 2					
Control	18	0.56	1.10	0.10	a
Intervention	20	2.50	1.04	—	—
Trust in organization Posttest 1					
Control	18	0.50	1.10	0.40	—
Intervention	20	0.85	0.82	—	—
Trust in organization Posttest 2					
Control	18	0.50	0.80	0.70	—
Intervention	20	−0.10	0.76	—	—
Adoption readiness Posttest 1					
Control	18	0.27	0.41	0.001	c
Intervention	20	1.55	0.30	—	—
Adoption readiness Posttest 2					
Control	18	0.28	0.59	0.28	—
Intervention	20	0.75	0.56	—	—

[a]Significant at 0.10.
[b]Significant at 0.05.
[c]Significant at 0.01.

Ringen and Stafford (1996) reviewed the literature pertaining to intervention research in construction occupational safety and health and recommended that additional research was needed to advance understanding of how to increase the adoption of less-hazardous equipment, materials, and tools. These authors state that "(r)esearch on market mechanisms, distribution systems, and contractor behavior is needed to better understand obstacles to the introduction of new technologies." The present study was conducted as a part of a larger initiative to scientifically understand the mechanisms and forces impacting the diffusion of Prevention through Design innovations within the construction industry.

The intensity of work, time pressures, frequent changes of work locations, and the trades' pattern for working in small firms are some of the factors that make it difficult to introduce safe work practices in the construction industry (Jensen and Kofoed 2002). Breaking down the barriers to change requires education and instruction by people who know the trade and can effectively communicate with construction workers (Jensen and Kofoed 2002). For a new tool or work method to be accepted, it must be easy to use, easy to understand, and fit into the culture of the trade. If these conditions are not met, the desired benefits may never be realized because the innovations were not given a fair chance due to the time pressures of construction work (Hess et al. 2004). The construction industry is a priority for research on interventions because of its high number of work-related fatal and nonfatal injuries (Hoonakker et al. 2005). Tailored interventions have been shown to be effective in promoting health behavioral change in construction workers (Sorensen et al. 2007). In a randomized-controlled design, Sorensen et al. (2007), found an educational intervention produced significant positive changes in rates of tobacco use and fruit consumption among construction laborers ($n = 582$).

Most interventions in the area of construction safety and health have not been theory-driven, which limits the understanding of what interventions work and the variables and methods that are important to implement in their design. Theory-driven interventions provide a conceptual framework for refining and improving existing hazard-control measures as well as aiding researchers design studies that are repeatable and generalizable (Goldenhar and Schulte 1996). Examples of workplace interventions that have used educational training sessions to improve worker behaviors include agricultural workers use of hearing protection, skin cancer prevention for farm workers, ergonomic interventions dealing with musculoskeletal disorders in floor layers and concrete workers, and lead-paint worker interventions (Goldenhar 1994; Parrott et al. 1996; Kirkhorn and Schenker 2002; Materna et al. 2002).

While this study describes one aspect of intervention effectiveness research, future work is needed to more fully develop this intervention research. As Goldenhar et al. (2003) describe in their conceptual model for intervention research, effectiveness studies should be performed within a larger context of intervention research, which also would include implementation and development inquiry. Therefore, future work is needed to expand our understanding of these key phases as they apply to the adoption of PtD innovation within the construction industry. In a review of intervention studies in occupational epidemiology, Kristensen (2005) recommends that the following aspects of the work system be included in any occupational intervention: work environment, worker health behavior, productivity, quality, and customer satisfaction. The intervention described in this paper factored most of those elements into its design. Missing, however, was consideration of the impacts of customer stakeholder needs on PtD adoption within construction firms. Future work is recommended to explore how customer stakeholders can serve as drivers of or impediments to technology adoption.

Practical Applications

The intervention strategy elements found to be effective in changing worker perceptions of dust-control technology included training, trial-ability, and cues-to-action. These techniques can be utilized by practicing OHS professionals to increase adoption and routine use of engineering control solutions in the workplace. The findings of this work can be directly applied to improve construction safety and health. To improve worker and contractor willingness to use safety equipment, training interventions can be developed based on the findings of these studies, in the following ways. Training should emphasize the health risks associated with the work. Workers should be provided with hands-on training until they become comfortable with the use of the new equipment. Contractors, if allowed to use the new equipment for a trial period in their actual work operations, are far more likely to become champions of the equipment, acquire it for their own use, and promote its use to others in their trade. Cues to action—visible reminders to use the new equipment—are also effective methods of improving worksite compliance regarding the use of new safety equipment.

Conclusion

This paper presents an effective intervention strategy to improve construction worker readiness to adopt ventilated sanding tools. It also sought to improve worker perceptions of their trust in the tools and their self-efficacy in using ventilated sanding tools. The intervention strategy aimed to address barriers to adoption of dust-control technology found in previous studies (Young-Corbett et al. 2010). Constructs specifically targeted by the intervention were perceived risk to health, health knowledge, trust in technology, trust in organization, and self-efficacy. These constructs are all expected to ultimately impact the model's endogenous construct: readiness to adopt. While the intervention strategy did positively impact participants' perceptions of their trust in the technology and their self-efficacy in using it; there was no significant impact on the workers' knowledge of health effects, perception of health risks, or trust in the work organization. Upon examination of the data, it was observed that pretest scores on the health knowledge and health risk constructs were already high at that point, meaning, the workers appeared to have high awareness of the dust health risks at the outset of the study. Therefore, the study would not have significant impact on those constructs. Trust in organization was not impacted in the study. Additional intervention elements to target that construct could be developed in future study. Interestingly, adoption readiness was highly significantly impacted in the intervention group in Posttest 1. However, by Posttest 2, 3 months later, there was no difference between the groups regarding readiness to adopt the tool. This finding would suggest that the change in adoption readiness is short-lived, following the training and trial-ability sessions. This is an important finding, particularly for practicing occupational safety and health professionals. It suggests that for an intervention to have lasting impact on adoption of control technology, more than a single point-in-time implementation is required.

Contributions to Body of Knowledge

Theory-based intervention strategies were found to be effective in improving worker willingness to use ventilated tools. The most impactful intervention methods included training regarding risks to worker health, hands-on training with ventilated tools, and cues-to-action reminders to use the tools.

The findings of this work can inform future research investigations in several ways. The Prevention through Design Adoption Readiness Model (PtDARM) can be used in future studies of intervention design, innovation diffusion, and health and safety behavior change. The validated survey instruments can be employed as data collection tools by researchers engaged in health and safety behavior research. Furthermore, the intervention strategies found to be effective in the current work can be applied to other PtD innovations, other construction trade sectors, and other occupational health and safety hazards.

Limitations

As with most survey research, the data collected was self-reported. This research was conducted in the United States during an economic downturn for the construction industry. Interventions might be less effective when an industry is faced with a declining market because support for occupational health and safety activities decreases (Goldenhar 2001).

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