

Control Equipment Characteristics Affecting WORKER PROTECTION DECISION-MAKING

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ACROSS THE U.S., workers use many chemicals during their workday. Not all, but many chemicals are harmful if inhaled. For small and medium-sized enterprises (SMEs), the owner or a designated representative is responsible for the decisions on how to protect employees. Various options exist for worker protection from hazards, including elimination, substitution, engineering controls, administrative controls and PPE. SMEs frequently utilize PPE and respirators as a common form of worker protection as a control for airborne hazards. Yet little is known about why these enterprises choose this type of protection, leading to question what forces might be driving the decision to adopt such poor controls for reducing airborne hazards.

DiMaggio and Powell's theory on isomorphism identifies the external forces that may influence employers' decision-making.

KEY TAKEAWAYS

- **Small and medium-sized enterprises frequently utilize PPE and respirators as a control for protecting workers from airborne hazards. Yet little is known about why, leading to questions about what forces might be driving the decision to adopt such poor controls for reducing airborne hazards.**
- **This article explores forces that may influence employers' decision-making about protecting workers and examines economic theories that may help explain employers' choices. Understanding these forces can inform efforts to help these enterprises choose better protection controls for workers.**
- **Through this study, qualitative data were collected from semi-structured interviews of small and medium-sized enterprises in the concrete trades exposed to a known airborne hazard. The interviews provided insight into the forces that employers experience in their decision-making.**

Organizational isomorphism includes three forces influencing organizations to act similarly to one another: coercive, mimetic and normative. Further, safety climate and organizational culture may explain internal forces such as safety culture on decisions and the intrinsic value of workers and the employer's need to protect them. Finally, economic theories of cost may explain why SMEs choose the method of protection. Knowing whether any or a combination of these forces influences health protection decisions made by employers, regulators, health associations, or safety and health professionals will inform targeting efforts to assist SMEs in choosing better protection controls for workers.

This research focused on small and medium-sized business owners or their representatives in four concrete trades to gain insight into the research questions. Qualitative data were collected from 20 semi-structured qualitative interviews of purposefully selected SMEs in the concrete trades, each exposed to a known airborne hazard for which they must protect workers. The interviews provided insight into the various forces that employers experience in their decision-making. The study revealed that characteristics of the control equipment was the major factor in the decision-making at these SMEs.

Introduction

SMEs in industrial trades and manufacturing commonly use respirators to protect workers from airborne hazards. Unfortunately, improper use of these respirators occurs and happens for many reasons, including worker fitness and stress (see, for example, Campbell et al., 2001). Ultimately, improperly used respirators translates into poorly protected workers and exposure to harmful chemicals. However, there are other more effective ways to protect workers from these harms than using respirators

known as the hierarchy of controls. This control system works from most effective controls to least by eliminating the chemical or substituting it with a less hazardous substance, engineering out the hazard or administratively controlling worker interactions with harmful chemicals.

In this study, the authors examined the decisions of leadership to use respiratory protection instead of more definitive control measures. As a result, this research question asked what forces influence the employer's decision to use respirators and not to use one of the methods higher in the hierarchy of controls. Some possible influences on decision-making include the company's internal culture, the low cost of respiratory protection, or the influence coming from outside the company from regulatory agencies or technical representatives such as safety and health consultants.

This project answered the question, What forces influence the decision of SMEs in the masonry and ready-mix concrete industry when choosing worker protection? This research investigated, through interviewing members of the Pennsylvania Masonry and Ready-Mix associations, the role of various forces in influencing the adoption of a particular control by organizations in three major categories:

1. cost forces: financial soundness of company, availability of control
2. internal forces: safety culture and organizational characteristics such as size of organization or transient nature of exposure
3. external forces: isomorphic forces such as awareness of hazard, awareness of control methods, use of internal or external certified industrial hygienist or other consultants, the influence from other companies or regulatory agencies

In the concrete industry where approximately 2.8 million workers are exposed daily to respirable crystalline silica (RCS) alone, respirator use has risen with the passage of the RCS standard in 2016 in both the construction and general industries (OSHA, 2016). Today, the respiratory protection manufacturing industry accounts for more than \$1 billion per year in sales in the U.S. alone. Innovation persists and respirators continue to be used in the workplace to protect workers from airborne hazards. However, even with the innovation and widespread use of respirators, respirators are not without significant limitations in their protection of workers.

Research has shown that a significant obstacle to respiratory protection program implementation has been getting workers to wear the respirator (Harber et al., 2013). Respirators can be uncomfortable, restrict a person's breathing and cause increased physical exertion (Shenal et al., 2012).

Maddux and Rogers (1983) also showed that worker use of protection equipment increased when they perceived the hazard as real and that their use of the equipment could reduce the hazard. However, White et al. (1988) interviewed approximately 169 painters in the construction industry and found that other factors influenced the painters' decisions to wear respiratory protection. They concluded that it was not just the consequences of not wearing a respirator that drove workers' decision to wear respirators but also the comfort level of the respirator and the perceptions by their peers while wearing them. Nevertheless, Li et al. (2002) showed that female workers were more likely than male workers to wear respirators properly, and PPE compliance increased as age increased. Additionally, if others in the workplace ridiculed the use of respirators, workers were less likely to use them. In general, this research highlighted multiple obstacles to enforcement of respirator policies in the workplace.

Thus, research has shown that there are many reasons workers do not use respirators to protect themselves. Further, even if

workers initially use respirators correctly, proper use degrades quickly after training (Harber et al., 2014). Therefore, relying on the worker to properly use respiratory protection is the primary reason considerable efforts are required to make PPE an effective means of worker protection.

Interestingly, no research has examined why employers choose this means of protection in the first place in comparison to control methods that require less commitment from the worker (e.g., engineering or administrative controls). The present study is the first to take a step back to ask decision-makers, then to qualitatively assess their responses. Using theoretical perspectives from economics and sociology, some potential reasons for these decisions are outlined below.

Social scientists emphasize that it is necessary to understand the culture created by an organization before that organization can be changed (Schein, 2011). Safety culture is a function that can be engineered and changed as needed (Tharaldsen & Haukelid, 2009). Therefore, whether safety committees and programs are created to generate the atmosphere or the atmosphere originated from the leadership, safety culture is intrinsic or internal to each company. This research looked at the influences on decisions made by management that could reflect safety culture.

Importantly, environmental or external factors may influence SMEs to make similar choices in independent decision-making when protecting workers in a particular way when it comes to respiratory health. DiMaggio and Powell (1983) termed this phenomenon isomorphism, whereby different organizations become more alike in responding to demands from external forces. They described the three mechanisms for the isomorphic change as coercive, mimetic and normative. Normative forces are those that are the accepted practices by a group of organizations. Mimetic forces are when one organization models its actions after another organization and coercive forces push the organization through negative or threatening actions (DiMaggio & Powell, 1983).

Normative forces are those external influences acting on many companies coming from one source, for example, a consultant working with several SMEs simultaneously. In business, specialty knowledge (e.g., accounting, legal, shipping) is necessary, and it is common for companies to outsource specialties such as safety and health to consultants (Johnstone et al., 2000). While organizations strive to voluntarily address environmental sustainability issues, they may enlist the aid of consultants. Consultants have great influence on their clients' decision-making (Martínez-Ferrero & García-Sánchez, 2017) during this interaction. The same information will be shared with all clients, so the response is expected to be similar.

Similarly, while working on safety and health problems a company may mimic the actions of other companies that have successfully innovated their own solution (Chai et al., 2019). Beckert (2010) revealed that the key factor driving mimetic isomorphism was the validation of institutional regulations used through an organization. Similarly, Bondy et al. (2009) determined that many organizations imitate the documents of others mainly because they want to reduce the uncertainty surrounding the content of the document and to minimize the learning curve necessary to get the document issued in the minimum amount of time.

Finally, coercive forces are those that compel companies into a course of action (DiMaggio & Powell, 1983). The most straightforward example of a coercive force is the myriad of government regulations and licensing requirements in place that constrain business operations. However, coercive forces can also stem from other sources such as the parent organization—in the case of subsidiaries

FIGURE 1 INTERVIEW GUIDE USED DURING MANAGEMENT DATA COLLECTION

and franchises. OSHA can be viewed as a coercive force. However, OSHA conducted 33,401 inspections during the 2019 fiscal year (Valentic, 2019) and according to the Small Business and Entrepreneurship Council in 2016, there were 5.6 million employer firms. Given the ratio of inspections to firms, there is slim chance that OSHA will be inspecting most employers to exert coercive forces directly. Knowledge of isomorphic forces acting on industries can assist safety and health professionals in understanding the obstacles and opportunities to helping employers protect their workers.

Methods

This study used both interpretive and positivist methodological research frameworks to investigate the influences on SME decision-making. Interpretive social science research seeks to study meaningful social action (Neuman, 2009), whereas positivist social science research makes empirical observations of a concrete reality to discover causal forces driving social activities. Therefore, with this research, SMEs were asked directly to verify whether the forces identified have validity on influencing decision-making or if possibly other forces might also act on the decision-making process.

The inquiry sequence included qualitative data gathering, or looking for emerging topics by using focused, purposeful samples (Patton, 2015). Qualitative interviews with SMEs' employers were used to examine the SME representative's perceptions of the forces and their impact on safety decision-making. Therefore, interviews asked SME decision-makers directly what forces influenced their decisions when choosing how to best protect workers from airborne hazards.

Interviews were conducted in a semi-structured format. Semi-structured interviewing uses a primary outline of question topics to cover in the form of an interview guide (Figure 1) but permit the interviewee room to discuss in more detail any areas pertinent to the discussion (Patton, 2015). Therefore, by using semi-structured interviews, the interviewee had the latitude to further explain circumstances and review other forces not directly asked about during the interview that may have been present. In addition, using this interviewing method allowed the interview to be more informal and less rigid. Ultimately, the open-ended nature of the interview conversations helped to uncover new forces not previously identified.

A homogenous purposeful sampling approach was used to determine who to interview and survey to gather data for this research. A homogenous purposeful approach for selecting participants permits the researcher to choose those subjects that may yield the most beneficial data (Patton, 2015). With a homogenous purposeful sampling strategy, the researcher selects companies to study that have similar characteristics and for which phenomena pertinent to the investigation is intensely expressed in the sample. The researchers selected employers from industries that had potential worker exposure to airborne RCS. Further, all the companies fall under the federal statute for worker protection to this hazard (OSHA, 2016). Therefore, the companies must assess their workplaces and choose a course of action to protect workers (OSHA, 1998) from RCS exposure.

The population for the study was SMEs with potential RCS exposure. The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing and publishing statistical data related to the U.S. business economy. Using the NAICS codes, interviewing targeted five NAICS codes from the concrete and masonry trades, two from manufacturing and three from construction industries.

Conducted using a semi-structured format, interviews asked small and medium-sized enterprise decision-makers directly what forces influenced their decisions when choosing how to best protect workers from airborne hazards.

You are answering these questions as a leader of your company who has decision-making authority for your workers' health and safety.

1. Describe your workers' potential to be exposed to silica dust in your organization.
2. Describe your approach(es) to controlling silica dust exposure to workers in your organization.
3. How often are your workers exposed to silica dust?
4. Describe the level of silica dust exposure to your workers.
5. If you use PPE, describe what type of PPE (if any) you use in the workplace to control silica dust exposure.
6. I'm going to give you a few reasons you might have selected to use respirators please describe how important is each of the following reasons for your selection of respirators as the approach for controlling silica dust exposure.
 - a. Initial cost is low.
 - b. It is easy to procure and readily available.
 - c. It is the approach most supported by top management.
 - d. It is the best way of controlling silica dust exposure.
 - e. It is the only approach to controlling silica dust exposure that I am aware of.
 - f. Government regulation is influencing the organization's choice.
 - g. It is the method recommended by the organization's internal safety and health professionals.
 - h. It is the method recommended by the organization's external safety and health consultants.
 - i. It is the method that my competitors use.

Demographic and other information (all respondents answer)

7. Safety culture index (series of three questions)
 - a. How active is your company safety committee?
 - b. Describe how accidents and injuries are investigated and recommendations made.
 - c. Describe how hazards in the workplace are analyzed and recorded.
8. Silica technical knowledge index (series of three questions)
 - a. What happens to workers who are exposed to airborne silica?
 - b. Describe any regulations for workplace exposure to silica.
 - c. Exposure to silica can be controlled using various different means.
9. How many workers does your company employ?
10. Do you have (or work with) a certified industrial hygienist or other professional? If so, describe what type of professional(s) you work with.
11. Financial stability index (series of three questions)
 - a. When was the last time the company reviewed the profit and loss statement for the business?
 - b. How would you describe the business's debt? Including any personal debt taken out for the business.
 - c. What type of plan does the company have in case of a cash shortfall due to late payments or an emergency expense.

Data collection included the completion of one interview with a management representative from 20 different volunteer companies in the targeted concrete industries. While reviewing answers to the interview questions, a coding system was used to categorize the data (Patton, 2015). Codes included the various forces that influenced the employers when deciding how to protect workers. DiMaggio and Powell's three isomorphic forces that may influence decision-making were used as sensitizing concepts for data coding (Patton, 2015). After each interview, the transcript was reviewed for comments relevant to the three categories of forces (see Table 1, p. 34). Once interviews were electronically transcribed by Zoom, the transcripts were uploaded into NVivo 12, a qualitative data analysis software program for coding.

TABLE 1
INFLUENCING FORCES ON DECISION-MAKING USED AS SENSITIZING CONCEPTS FOR DATA CODING

Results

Cost Influence on Decision-Making

Cost is a significant force that could influence SMEs’ decisions for worker protection. SME representatives’ perception that filtering facepiece respirators cost less than engineering controls subsequently affected their selection due to their lower cost. Based on the interviews, the money SMEs spent to protect workers was a concern (e.g., influencing factor), although the direct costs of respirators or other protective measures were not the driving force influencing the SME representatives’ decision to use one method of control or another to protect workers. For instance, the manager of a small ready-mix company stated, “I mean, the PAPRs are a pretty big investment. And he (the owner) didn’t even blink. . . . Then I get it done.” This shows that the owner and others looked at the options and, knowing that the powered air-purifying respirators are more expensive, they still chose to use them.

Internal Forces on Decision-Making

Internal forces such as safety culture, worker retention and the nature of work tasks come from within the company. To assess the internal forces during the interview, SME representatives were asked about their safety committees and whether the committee met regularly, identified hazards throughout the company and investigated workplace injuries. A strong safety culture may indicate that an internal force motivates the company when selecting protective measures for employees.

All employers interviewed stated that they had a safety committee that engaged in the safety of their organizations. Of note, all SMEs stated that they stopped using filtering facepiece respirators in favor of other control methods and only have the filtering facepieces available if a worker wishes to use one. As the operations manager at a precast manufacturing facility of approximately 90 employees stated, “I have a box of disposable masks that I keep in the cabinet in case anyone asks for one.”

Coercive Forces on Decision-Making

With internal forces, SMEs act on their own to protect workers. The opposite of this would be if the SME were made or coerced to protect workers. Coercive forces are one of the three isomorphic forces presented by DiMaggio and Powell (1983). All SMEs selected for this study were in industries under OSHA jurisdiction. Therefore, OSHA enforcement activity was omnipresent, and the new RCS standard strongly influenced SMEs to act. The data reflected that the initial force pushing SMEs into action was by the regulatory agency, as 75% of interviewees shared that they were not concerned about silica exposure or taking action to reduce worker airborne concentrations until OSHA pursued it. For example, a concrete contractor with fewer than 50 workers stated, “The regulations have really made, you know, a huge difference in the awareness for the men and women in the field.” A ready-mix SME said, “OSHA regulations actually brought [silica] to our attention.” However, OSHA has inspected none of them.

OSHA is not the only coercive force. For example, a general contractor may put safety policies into effect on its jobsite that affect subcontractors. As this small concrete contractor explained, “I’m a subcontractor for general contractors, and they’ve set up with the same equipment. So, their safety people do keep an eye on it to make sure you’re in compliance.” Similarly, large companies exert significant influence over the companies they hire to perform work at their company. As one hardscaping SME said, “I would say our clients [influence us]. . . . They also have some very stringent safety policies in place that we must follow when we’re

Theoretical forces	Sensitizing concept
Cost force category	
Cost	<ul style="list-style-type: none"> • Availability of control • Initial cost • Usefulness of control • Ease of use of control • Financial viability of company
Internal force category	
Culture	<ul style="list-style-type: none"> • Age of company • Size of company • Tenure of workers • Safety committee • Investigation of injuries
Knowledge	<ul style="list-style-type: none"> • In-house safety and health staff • Attendance to trade organization training • Self-study
External forces category	
Mimetic	<ul style="list-style-type: none"> • Looking to competitors for help • Looking to larger companies for help
Coercive	<ul style="list-style-type: none"> • Regulatory agency telling company • General contractor requirements • Client requirements
Normative	<ul style="list-style-type: none"> • Health and safety consultants • Trade organizations • Insurance companies

on site as well.” In the end, for this SME, it was a matter of doing what the client wished or not working at that facility.

By starting with intrinsic (internal) and coercive (external) forces, the researchers created an initial framework (Figure 2). On one side are SMEs that need little or no external force, and on the other side are SMEs that require a strong external force.

Other External Forces on Decision-Making

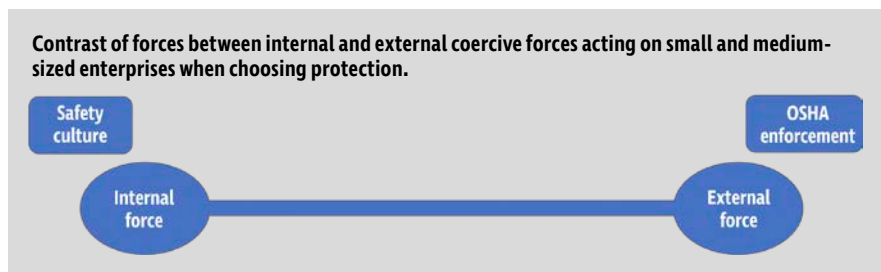
Using DiMaggio and Powell’s (1983) theory of isomorphic forces, a second force acting on SMEs is normative force. Normative forces are associated with professionalism and not always empirically distinct (DiMaggio & Powell, 1983), which means that the force exerted on another comes from some external force pushing [WC] a company. The interview data reflected four primary sources of normative force: safety and health consultants, insurance companies, trade associations and Table 1 in the OSHA RCS standard. Every SME stated that they use at least one of these four methods to assist in their selection, which fit between the opposite extremes of the internal and external forces (Figure 3).

For example, the SMEs in general industry (e.g., the ready-mix and precast companies) used safety and health consultants such as the Pennsylvania (PA) OSHA On-Site Consultation Program or private commercial safety and health consultants. The PA OSHA On-Site Consultation Program is a free safety and health consultation program available to SMEs upon request throughout the state. The owner of a hardscaping company of fewer than 10 employees said, “I used [PA OSHA Consultation] to evaluate our bagging and block processes.”

In another example, the human resources manager at a ready-mix plant with two locations uses the employer’s insurance company to help out at a second location: “So our insurance company . . . I do use them a lot at our other facility.”

Thirdly, several SMEs are part of the Pennsylvania Concrete Masonry Association (PCMA) and utilized their membership

FIGURE 2
CONTRAST OF FORCES

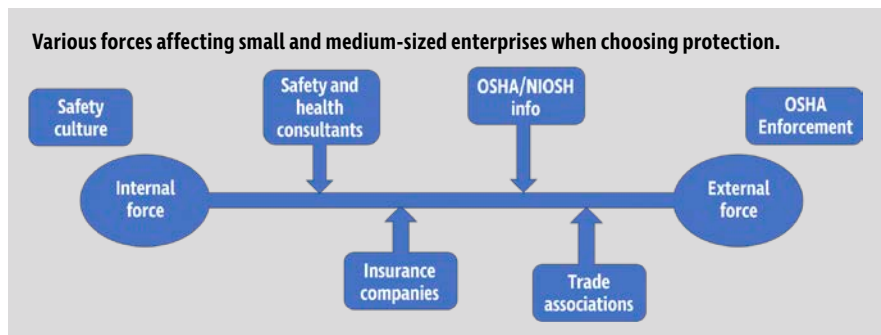


protect workers. However, disposable filtering facepiece respirators were available at any home improvement store.

The demand for tools with integrated dust controls began to increase after 2016 and even more after 2018, when all employers had to have their RCS exposure control plans wholly implemented. Ultimately, various SMEs mentioned four characteristics related to equipment during their interviews: availability, usefulness, ease of use and employee preference (Figure 4, p. 36).

First is availability; as noted, before 2016 and OSHA's RCS standard, there was little demand for equipment with integrated controls for RCS. Therefore, few equipment companies developed control equipment. SME representatives stated that protection measures such as tools with integrated local exhaust ventilation or water suppression were not readily available. As a family-owned ready-mix owner in western Pennsylvania stated, "We changed out our

FIGURE 3
FORCES AFFECTING PROTECTION CHOICE



to learn more about the RCS hazard. Some trade organizations promote quality standards that indicate a level of excellence on its part and endorsement by the association. A concrete contractor from Maryland stated, "I've taken the PCMA course twice. So, I sort of fancy myself to be a train-the-trainer." Many SMEs are members of trade associations to gain timely information about new regulations and come together to share ideas.

Lastly, SMEs have a ready resource in the construction industry to help them select protection: Table 1 in the OSHA RCS standard. Based on historical industrial hygiene sampling results and to ease the burden on the construction industry, OSHA created a table in the RCS standard delineating the use of basic controls. The table reflects the task performed, location of work (outside vs. inside) and duration of task (less than or greater than 4 hours). OSHA published its requirements in what is commonly referred to as Table 1 of the RCS standard. When interviewed, SMEs made comments such as, "I post a copy of Table 1 in the job trailer for the workers to see" and "I just use Table 1 when I spec out a job."

Mimicking Other Companies

The last external force developed by DiMaggio and Powell (1983) are mimetic forces. The use of mimicking is more common when the answer is unknown (DiMaggio & Powell, 1983). In this study, there are well-established means to control the hazard and protect workers. From the interviews, only one company stated modeling its safety and health program after another company. A small masonry contractor with fewer than 25 workers stated this about the contractor's safety and health plans: "We model a lot of [safety and health plans] after the general contractor that we work most frequently with."

Equipment as a Force Influencing Decision

As noted, SMEs selected a control even if it was more expensive than other options. Basic economics tells us that cost is directly tied to supply and demand. Simply put, as demand rises, manufacturers supply more. Before 2016, little demand for protection other than filtering facepiece respirators existed. Consequently, few commercially available options existed to

batch mixing units 10 years ago, and we had to come up with our own way to hose down the conveyor." Now there is plenty of demand for new equipment. One concrete contracting company from Maryland relayed during the interview that as a new piece of equipment becomes available, his vendor calls him to ask if he wants to try out the new tool.

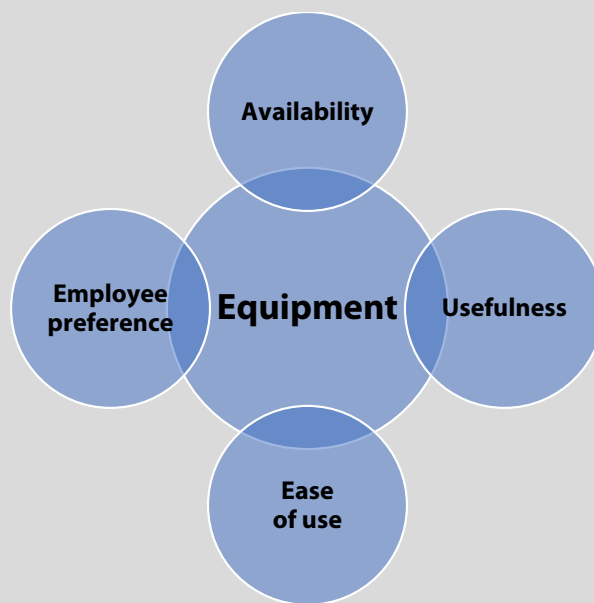
Second, the protective measure must be useful to the worker in terms of the equipment needs to work. The SME representative from the Maryland concrete contractor mentioned, "Some of the old concrete grinders used to break up concrete with local exhaust ventilation installed reduced [the worker's] ability to work due to the filter getting clogged up and having to be cleaned several times during the workday." He continued, "Later on, the local exhaust equipped grinders provided more efficient filters that periodically pulsed and cleared themselves, allowing the worker to continue uninterrupted."

This example also could be used to demonstrate the third consideration: ease of use. The representative from a concrete contracting company from Texas that specializes in the rehabilitation of old buildings and performs tuck-pointing describes his obstacles using dust control measures. Tuck-pointing is grinding out old, degraded mortar between bricks and concrete blocks and applying new mortar to give a clean look on a historic commercial building. Grinding out the old mortar generates a lot of dust containing RCS and significantly exposes workers. The SME representative explained that running waterlines or vacuum hoses used in locally equipped grinders was infeasible when the workers were several stories in the air and when the building was huge like those in cities. He stated that a few years ago it was easier to use respirators to protect workers in these hard-to-reach areas. However, now equipment companies have developed portable grinders with exhaust ventilation or with a water supply that can be carried by the worker or that was portable enough to be set up on the scaffolding in the remote areas where they were tuck-pointing.

The final equipment consideration was employee preference. One company representative mentioned that he chose to use hooded powered air-purifying respirators (PAPRs), knowing the level of the worker exposure to RCS only required a half-face

FIGURE 4 EQUIPMENT CONSIDERATIONS

Small and medium-sized enterprises' equipment considerations when choosing worker protection.



air-purifying respirator. Hooded PAPRs provide about 10 times more protection than filtering facepiece respirators. He said that he chose the PAPRs because workers preferred them over the filtering facepiece respirators since the PAPRs were more comfortable to put on and blew air on their heads, helping to cool them. He felt that if the workers were happy and would willingly use the protection, they were worth the extra cost.

Ultimately, these four factors about equipment—effectiveness, usefulness, availability and worker preference—increased demand for better equipment and provided more choices of protection for workers. Equipment characteristics were the main limiting force that influenced SMEs when choosing protection for workers.

Discussion

During the interviews, SMEs appeared to value their workers as part of the business and social enterprise, as the human resources and safety manager of a ready-mix plant noted, “At the end of the day, if we don’t do what we need to do, and there’s no more business, you know, if I’m not providing for these guys to be able to provide for their families. So, you know, that’s how we look at it.” Some look at their company employees as an extended family. As a small ready-mix plant manager stated, “Probably one of the things that I’d add is that the owner, the company’s, is committed to the safety of the employees. I mean, he treats his employees like they’re family.” When taking responsibility for others, SMEs strive to protect their workers. Further, the SMEs indicated that they may never get inspected by OSHA and told what to do nor have in-house technical resources to choose a course of action. Therefore, the cost was always a factor for SMEs when choosing protective controls for employees; however, selecting the cheapest item was not usually the first reason for their selection. Most looked at the longer payback as well as the other benefits a control measure may provide.

Since none of the SME representatives stated that they modeled their protective measures after what they saw another company do, it was concluded that mimetic forces had little influence on SME decision-making. However, as noted, this outcome was expected, given the known nature of available control measures and worker protections available for silica. Alternatively, cost was a force expected to influence SME decision-making. However, it had only minimal impact. Therefore, SMEs often seek outside help for more information when choosing how to protect workers. This information can come from several sources, such as getting help from safety and health consultants, visiting workers’ compensation companies and learning from trade organizations.

SMEs had restrictions (e.g., factors having impact) on their decision-making even after learning more about their exposures and options to control the hazard from consultants, insurance companies, trade associations, or merely using OSHA’s Table 1. Restrictions came from the equipment itself that they needed to control the dust. Even OSHA’s Table 1 only specified “use equipment equipped with integrated water system” or “operate and maintain tool per manufacturer’s instructions.” When the SMEs first started to address the RCS hazard, few options existed from which to choose. However, as demand increased, manufacturers started to innovate and create new equipment to control dust. Four factors were considered by SMEs when selecting equipment: availability, effectiveness, ease of use and, ultimately, if workers liked to use the equipment.

Isomorphic forces influenced SMEs to act, understand the workplace hazard and ultimately select the course of action. Interview data indicated that mimetic forces only minimally influenced SME decision-making. However, this may have

been because the hazard (silica) is well defined with established control techniques. Normative forces exerted significant influence by supplying information to the SMEs. The information enabled SMEs to make informed decisions. However, even knowing about the hazard and the options to reduce worker exposures, the actual equipment availability proved to be most crucial to the SMEs’ control selection to protect their workers.

Conclusions & Recommendations

Initially, cost was given as the possible force influencing exposure control decision-making. However, SMEs commented that they might choose a more expensive option for various reasons, all relating to the characteristics of the equipment. The equipment chosen needed any of four primary characteristics for the SME to select it to protect workers. The first was availability; the easier the control is to find and purchase, the easier it is to procure. Second, the control must be useful; if the control does not effectively reduce the hazard, SMEs will not use it. Third, the control must be easy to use; if the control is too complicated or cumbersome, workers will not use it. And fourth, the workers must prefer the control; if workers did not like to use the control for the task, they would not use it. Some characteristics, such as ease of use and worker preference, may come after selecting the equipment. However, some equipment vendors allow companies to try the equipment before purchase. For example, Scott, who owns a concrete contracting company in Maryland, mentioned that when his vendor gets a new piece of equipment, Scott is one of the vendor’s first calls to see if his workers want to try it out.

Insight into the characteristics of the equipment as a significant force influencing the selection of protective measures for employees can ensure timely and effective control of airborne hazards in the workplace. By involving equipment manufacturers whenever a hazard is identified, providing information to these equipment manufacturers regarding workplaces where workers could be exposed, and knowing specific tasks to be performed, controls can be created with favorable characteristics for their adoption. Once control equipment is available, SME demand will drive other manufacturers to improve designs and advance the equipment capabilities, such as was the case with the employer performing tuck-point operations several stories in the air. When the water supply was brought up on the scaffolding in

portable containers, SMEs changed from filtering facepiece respirators to engineering controls for this high-exposure operation.

Based on this study's data, SMEs select readily available, effective, easy-to-use and worker-preferred equipment. Increasing demand for equipment in the workplace permits manufacturers to create better equipment. Lastly, having more control equipment options enables SMEs to select better workplace controls.

This study used a well-defined set of industries experiencing a known airborne hazard with an established exposure limit and effective control measures available. This study was the first to ask SMEs directly what influenced them regarding the selection of controls. Further studies should be conducted to confirm this study's findings. There are other industries with hazard exposures where any one or more of these is not the case. Following are a few areas for future research for investigating forces in deciding on controls to adopt.

1. Interview companies beyond the confines of this study, possibly with airborne hazards that are not well known and need to establish exposure limits or adequate controls.

2. Study a hazard that does not have an OSHA standard.

Ultimately, by giving the SME leadership information about the hazard and the equipment to control it, the SME protected workers using the most efficient means for their circumstances. This resulted in the SME's use of controls higher on the hierarchy of controls than filtering facepiece respirators. Ultimately, except for emergencies, SMEs or any employer should always consider respiratory protection as an interim protective measure only to be used until the implementation of a permanent solution to avoid or eliminate exposure. **PSJ**

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Ethics Review

This research was reviewed and approved by the Indiana University of Pennsylvania's Institutional Review Board, Approval No. 20-006.

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