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Organizational Characteristics of Small Metal-fabricating Businesses in Minnesota

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Small U.S. businesses are underserved in terms of occupational health and safety (OHS) services. Little is known about organizational factors influencing OHS in these establishments. Machine guarding was quantitatively evaluated in 40 small businesses. Checklists were used to develop safety scores. Organizational information such as number of employees, unionization, and number of machines was obtained. Experience modification rates, annual sales, and credit ratings were also obtained. Safety scores were divided into terciles. Businesses with safety scores in the top third were unionized, had effective safety committees, and had been operational for more than 30 years. Interventions and policies targeted toward development and implementation of safety committees are needed to improve OHS in this cohort. Financial capability had no bearing on ability of a small business to mount an OHS programs. Non-unionized small businesses may be more vulnerable to occupational injuries. *Key words:* organizational characteristics; small business; machine guarding; occupational health.

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Over 97 million workers in the United States are employed in 6.5 million small and medium-sized businesses with fewer than 100 workers. This constitutes approximately 50% of the U.S. workforce.^{1,2}

Workers within small businesses have higher rates of injury and illness than those in larger businesses.³⁻⁷ Small businesses employ a disproportionate number of workers who are considered to be at high risk for workplace injuries because of their lack of experience and knowledge and their employment in unskilled jobs.⁸ Higher

injury rates among small businesses have also been attributed to lack of unionization and failure to invest in occupational health and safety (OHS) programs.⁹⁻¹¹

There is limited literature concerning organizational characteristics that influence occupational safety within these establishments. Factors cited in the literature include a lack of full-time staff devoted to safety, as well as failure to utilize safety consultants and obtain formal safety training, when compared with their larger peers.¹² There has been discussion concerning the importance of organizational factors and their influence on OHS policy. However, it is difficult to discern the best way to measure these policies and how they might be modified to assist both owners and workers.

Some reviews of health and safety in small businesses have investigated, among other things, relationships between workplace size and injury rates; levels of compliance with health and safety provisions; and administrative, organizational, financial, and motivational reasons for a lack of management attention to health and safety.¹³

Champoux et al. reported occupational health services data from 223 small businesses in Canada. Data from this study suggest that interventions with small businesses should be aimed at specific subgroups of small firms based on their safety practices, their owner-managers' perceptions, and their management styles, as well as on certain organizational characteristics.¹⁴ However, specific recommendations relative to work practices were not made.

Eakin et al. reported the need to better understand the organizational policies and incentives that may improve workplace safety in small businesses.^{15,16} They assert that attempts to address health and safety in small workplaces have failed to acknowledge the distinctive social and organizational characteristics of these establishments.¹⁷

In summary, there is little evidence in the literature concerning the specific organizational characteristics of small business establishments that contribute to safety in the working environment. Specifically, little is known about how size, union status, number of years in business, type of industry, communication systems (e.g., safety committees and suggestion box), credit ratings, annual sales and experience modification ratings influence health and safety.

This research was part of the Minnesota Machine Guarding Program, which examines the effectiveness

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of interventions aimed at improving machine guarding and related programs in small metal-fabrication businesses. A randomized controlled design study is being used to compare the effectiveness of interventions directed at both owners and workers versus those directed solely at owners.

The data were collected for baseline evaluation of 40 shops. The present study explored the relationships between the organizational characteristics of safer small metal-fabricating businesses compared with contemporaries in the same industry that were less safe based on objective quantitative measures of machine safety and related programs.

For the purpose of the study, we classified the organizational characteristics into those that cannot be changed (intrinsic) and those that may be modified (extrinsic) through reasonable interventions by owners or managers. Intrinsic characteristics include business traits such as standard industrial classification (SIC) codes, years in business, union status, number of machines, and number of employees. Extrinsic characteristics include safety committees, safety-suggestion systems, and machine safety policies.

METHODS

Community Advisory Board

A community-based advisory board composed of a union representative, small business owners, safety consultants, a trade school educator, and representatives of Minnesota OSHA and the Minnesota Department of Trade and Economic Development was convened. Board members helped identify the most important industrial sectors (by SIC) engaged in metal fabrication in Minnesota and the types of machines commonly found in those facilities. The board also assisted with the development, testing, and revision of intervention and evaluation materials.

Business Recruitment and Demographics

Metal-fabrication facilities from the Twin Cities metropolitan area were eligible for study participation if they met the following criteria at the time of recruitment:

1. Total employment of five to 100 workers at the study site (only one site of a multisite company could participate)
2. At least ten metal-fabrication machines from a list of 23 different machines from five machine categories: (1) milling, drilling, boring; (2) cutting, shearing sawing; (3) presses; (4) rolling, bending; (5) sanding, grinding
3. In business for at least one year prior to recruitment
4. Located within approximately 50 miles of the study office

TABLE 1 Industries Participating in the Study by Standard Industrial Classification (SIC) Codes

Industrial Category	SIC Code	No. of Shops
Fabricated structural metal	3,441	4
Sheet metal work	3,444	2
Architectural and ornamental metal work	3,446	3
Metal stampings (not elsewhere classified)	3,469	13
Fabricated metal products (not elsewhere classified)	3,499	4
Special dies and tools, die sets and fixtures and Industrial molds	3,544	1
General industrial machinery and equipment	3569	1
Miscellaneous industrial machinery	3,599	11
Garden supplies	5,261	1
Total	—	40

5. In an industry with at least one of the 13 primary SIC codes (Table 1).

This definition was met by approximately 240 businesses in the Minneapolis and Saint Paul metropolitan area.¹⁸

The principal investigator (DLP) recruited the owners or their representatives. Businesses were recruited to the study primarily through personal introductions from union leaders, insurance companies, shop employees, and other owners. Shops were also identified using business directories and meetings with metal fabrication trade groups. After being sent a letter of introduction, a shop representative was contacted by telephone for an appointment with the owner or manager.

At the initial meeting, demographic data, including the types and numbers of machines, union status, numbers of employees, managers, years in business, and the number of non-English-speaking workers, were obtained.

Experience Modification Rates

The experience modification rate is a credit or debit factor based on a business's injury and payroll history.¹⁹ The closer the experience modification rate is to zero the better. Safety programs established within each business are important in keeping the experience modification rates low. We obtained information about experience modification rates for businesses recruited in this study from the Minnesota Workers' Compensation Insurers Association. Information concerning a business's credit rating and annual sales was obtained from a business database.^{18,19}

Machine Safety Evaluation

Machine safety scorecards were used to quantify the degree and adequacy of machine guarding for each of

Item	Present	Absent	Not Assessable
Tongue guard			
Present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Distance from wheel not more than 1/4 inch	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good condition (no cracks, clean)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Yellow color	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool-rest			
Distance from wheel 1/8 inch or less	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good condition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Yellow color	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Moving Parts (belts, pulleys, chains, sprockets) guard			
Guard present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Guard yellow in color	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Moving parts orange in color	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Guard in good condition (no cracks, clean)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Abrasive wheel			
Good condition (not cracked)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Coasting time less than 1 minute	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rated speed of the grinding machine does not exceed the rated speed of the grinding wheel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 1—Sample machine guarding scorecard for a pedestal grinder. This is a partial scorecard due to the space needed for more complete publication. Scorecards may be obtained by contacting the authors.

23 commonly used metal fabrication machines. These 23 machines were identified by the Advisory Board and were classified into the five categories.²⁰

We used a combination of engineering and policy criteria to develop scorecards. Criteria included:

1. Guarding and/or devices at the point of operation
2. Guarding of moving parts (e.g., gears, pulleys)
3. Adequate labeling of machinery (e.g., machine model, electrical data plate)
4. Presence of emergency stop
5. A slip-free, uncluttered, and adequately lit work area
6. Adequate electrical wiring (e.g., no worn or damaged wires)
7. Clear lockout/tag out procedures^{21–24}

Based on these criteria, a stratified random sample of ten to 25 machines was assessed in each participating business by trained evaluators.²⁰ Each sampled machine was rated on a scale of zero to 100% using pre-tested machine scorecards. A score of 0 was assigned to a machine when none of the items on the safety scorecard was present on the machine. A score of 100% was given if all the items present on the scorecard were on the machine and in proper working condition.

Each business establishment received an average machine score based on the scores obtained for the machines sampled in that facility. For example, if ten machines were included in the sample, the average score received by those ten machines was assigned as

the machine score for that business. More details about sampling of machines, machine-evaluation protocols and development and testing of machine safety scores can be found elsewhere.^{20,25} A sample machine scorecard for a pedestal grinder is shown in Figure 1.

Shop Environment and Safety Program Evaluation (Shop-safety Scorecard)

A shop-safety scorecard consisting of 25 questions was used to evaluate three aspects of overall shop safety: the general shop environment (e.g., lighting, safety bulletin board), administrative and management policies (e.g., presence of safety committee, safety committee meeting minutes, maintenance of OSHA 300 log), and employee-related work practices (e.g., use of protective eyewear, documentation of employee training). Items for the shop-safety scorecard (Figure 2) were drawn from the most frequently cited OSHA violations in Minnesota metal-fabrication businesses, inspection and audit forms used by Oregon OSHA,²² Form 33 developed by United States OSHA,²⁶ machine hazard evaluations developed by Ohio State University (2004), a workplace injury-reduction program (AWAIR) developed in Minnesota by OSHA,²⁷ and the OSHA 300 log.²⁸

Of the 25 items on the shop-safety scorecard, ten were evaluated by directly observing employee work practices (e.g., wearing safety goggles, safety shoes). The remaining 15 items (e.g., safety committee meeting minutes, records of lock-out training) required inspection of written records. The latter items received

	Methods of Evaluation	Yes	No
Environment			
Is permanent wiring (conduit) used instead of extension cords?	Direct observation		
Is lighting adequate in work areas and walkways?	Direct observation		
Management and Administration			
Are minutes kept of safety committee meetings?	Inspection of records		
Is the OSHA 300 log maintained?	Inspection of records		
Employeeess			
Is there adequate personal protective equipment?	Direct observation		
Are there records of employee training in machine guarding procedures?	Inspection of records		

Figure 2—Sample of the shop-safety scorecard by category.

a score of zero if no written record of a policy or training record was available. Each item on the shop-safety scorecard received four points, for a maximum shop score of 100% (25 items \times 4 = 100).

DATA MANAGEMENT AND ANALYSIS

Data were scanned into a Microsoft Access database and analyzed using SAS statistical software.²⁹ We developed a composite score based on the machine and shop checklist scores for each small business. The composite score for each business could total 100%, of which 70% consisted of the average machine safety score and 30% consisted of the shop-safety score. The composite score provides a comprehensive safety profile of each business.

Stratified analyses were done using Fisher's exact test. Businesses were stratified by size (< 25 and 25+ employees). Twenty-five was selected as a stratifying number because Minnesota OSHA requires all businesses with 25 or more employees to have a safety committee. In addition, the 40 businesses were divided into terciles based on their composite scores. Group 1 was shops with composite scores in the top third (66–75%; $n = 13$), group 2 (60%–62%; $n = 14$) in middle third, and group 3 (48–59%; $n = 13$) the lowest third. We used a trend analysis to determine the effects of organizational characteristics on the composite scores across the three groups.

RESULTS

Forty metal-fabrication shops were evaluated. Standard industrial classification (SIC) codes are listed in Table 1. Eighteen businesses were located in Minneapolis or Saint Paul and 22 businesses were located in suburbs. The average composite score for the 40 shops was 63%. Businesses in Minneapolis and Saint Paul had a shop score of 64% compared with 61% for suburban shops ($p > 0.05$).

Eight hundred twenty-four (824) machines were assessed. The distribution of machines by machine category (e.g., milling, drilling) is shown in Figure 3. Shops had an average of 37 machines (SD = 27, range 5–100). An average of 36 employees worked at each site (range 4–98), and the shops had been in business for an average of 34 years (range 3–90). Thirty percent of the shops were unionized, 57% had a safety committee, and 79% had a safety suggestion system consisting of either a suggestion box or an informal communication system.

Table 2 shows the organizational characteristics that influenced the composite scores. Trend analysis was used to examine the differences between the three groups. Eighty-five percent of group 1 businesses had a safety committee, compared with 71% of group 2 and 15% of group 3 ($p < 0.05$) businesses. Forty-six percent of group 1 businesses were unionized, compared with 43% of group 2 and 8% of group 3 ($p < 0.05$). Seventy-five percent of group 1 had been in the trade for more than 30 years, compared with 54% of group 2 and 33% of group 3 ($p < 0.05$). No relationship was found

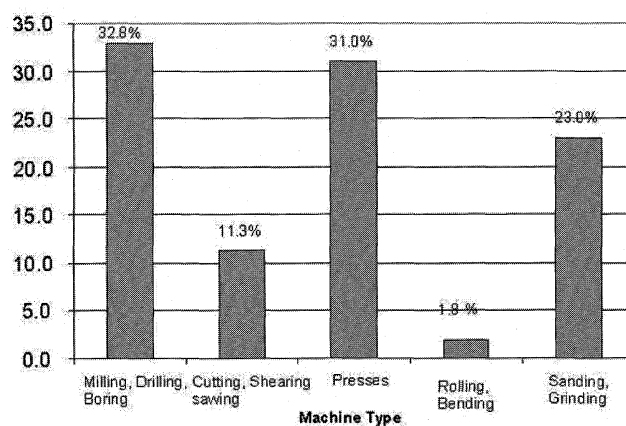


Figure 3—Machine categories included in the study, by percentages across the 40 small businesses. X axis: type of machines; Y axis: percentage of machines.

TABLE 2 Trend Analysis Showing the Effects of Organizational Characteristics on Composite Scores by Group (Terfile)

	Group 1 (n = 13)	Group 2 (n = 14)	Group 3 (n = 13)	P
Safety committee present	85%	71%	15%	0.0004
In business for > 30+ years	75%	54%	33%	0.04
Unionized	46%	43%	8%	0.04
Average number of employees	44	32	33	0.52
Average number of machines	41	38	30	0.46
Average experience modification rate	0.80	0.99	0.95	0.34
Average annual sales in million of dollars	18.2	11.4	8.3	0.24
Composite score range	66.3–75%	60.9–66.2%	48.4–60.8%	

between size (in terms of both employees and machines), experience modification rates, annual sales of a business, and the composite scores.

As shown in Table 3, establishments with a safety committee had a significantly higher composite score than did businesses with no safety committee. This finding was true for both the businesses with fewer than 25 employees and those with 25 or more employees. Safety-suggestion systems positively influenced the composite scores in shops with 25 or more employees, but the presence of a safety-suggestion system did not seem to influence the scores in shops with fewer than 25 employees.

The mean annual sales figure for these 40 businesses was \$12 million (range: \$1.75–75 million), and the mean experience modification rate was 0.92 (range: 0–1.56). Thirty-seven businesses were found to have excellent credit ratings, credit reports for two businesses were absent, and one business had a good credit rating. No statistically significant relationship was found between the composite scores and experience modification rates, credit ratings, or annual sales.

DISCUSSION

Our findings depict a model safe small business in the metal-fabrication industry. The model establishment is unionized, has been in business for more than 30 years, has a safety-suggestion system, and has an effective safety program. Sales or credit rating do not appear to affect safety measures.

Among the extrinsic (i.e., modifiable) organizational characteristics, we found that safety committees made significant differences in the composite scores. These findings are consistent with those of Shannon et al., where an effective joint health and safety committee had decreased the lost-time injury rates in manufacturing industries.³⁰ In a study of 127 manufacturing firms, Boden et al. found that health and safety committees significantly reduce regulatory citations.³¹

In our study, unionization significantly and positively influenced composite scores. This finding is similar to that of Taylor, who reported union coverage to be associated with fewer workplace injuries.³² In a similar

study concerning health-promotion activities in small businesses of Australia, Holman et al. reported a positive association between trade unions and workplace health-promotion activities.³³

Our study did not find any relationship between the composite scores for small businesses and the sizes of the businesses in terms of number of employees or number of machines. This differs from findings from other studies of small businesses that reported a relationship between business size and the presence of workplace health-promotion and safety programs.³⁴ The reason for the inverse result in our study is that we chose to concentrate on small (< 100 employees) and very small businesses (5–50 employees) as opposed to other small-business researchers who have included establishments with up to 500 employees in their studies.^{34,35} In addition, we examined workplace safety only and did not examine the presence or absence of health-promotion activities.

Intrinsic organizational characteristics that positively influenced safety in this study were unionization and years in business. These factors cannot be modified by a policy or educational intervention, as market and labor forces govern these attributes of a business. However, extrinsic organizational characteristics such as safety committees and safety-suggestion systems may be changed by a policy or educational intervention, as these factors are independent of market forces, minimally impact operational costs, and are not time-consuming to implement. Further, the safety committee in a small business may also be used as a vehicle for inducing organizational change to apply health-and-safety-related policies.

Our study refutes the common belief that small businesses may be less safe due to lack of economic resources.^{17,10} This study found no relationship between extrinsic organizational characteristics, total annual sales, or credit rating and their influences on the composite shop score. Champoux and Brun reported that most small business owners do not think that resources are significant barriers to their improvement of health and safety measures. Only 37% of 223 owners of small businesses (fewer than 50 employees) thought cost was an important barrier to health and safety improve-

TABLE 3 Shop Organizational Characteristics vs Composite Score (Two-group) Stratified Analysis by Shop Size

	<25 Employees (n = 19)			25+ Employees (n = 21)		
	Low Composite Scores	High Composite Scores	P	Low Composite Scores	High Composite Scores	P
Safety committee present	27	75	0.04	22	100.0	0.0001
Safety-suggestion system present	73	88	0.44	50	100.0	0.02

ments.¹⁴ In another survey conducted among small enterprises of five western European countries, only 30% of the establishments reported cost as a barrier to improvement of health and safety measures.³⁶

These findings suggest that a lack of economic resources may not be the sole reason for less safe workplaces. Rather, as seen in this instance, it is the failure to develop and implement low-cost organizational systems such as safety committees and safety-communication systems that contribute to a safe workplace. However, the development of safety committees has been shown to be somewhat dependent on unionization. It may also be dependent on legislation mandating safety committees as a mechanism to implement occupational health and safety legislation. For example, Minnesota has legislation mandating safety committees in establishments with more than 25 employees.³⁷

LIMITATIONS

There are several limitations to the data collected in this study. First, efforts to recruit businesses directly from a listing of all businesses proved difficult, so we relied largely on referrals. When we contacted owners who did not have knowledge of our program they were reluctant to speak with us; thus referrals served as a major means of recruitment.

The most common reason owners gave for not participating was that they were too busy, and secondly, that insurers provided for their health and safety needs. Non-participating shops were similar in size and SIC codes to participating shops. For these reasons it is likely that participating and non-participating shops are not substantially different.

Second, experience modification data take up to a year to reflect any occurrence of injury in an establishment; thus, conclusions based on these data must be interpreted with discretion. However, in this study, we included credit rating and annual sales in addition to modification rates as indicators of financial capability, and none of these factors showed a significant relationship with the ability of a business to implement occupational health and safety programs.

Finally, the metal-fabrication trades have come under enormous financial pressure over the last decade. This has resulted in the closure of several shops, including two of the original 40 recruited for

participation in the Minnesota Machine Guarding Study. It was not possible for us to compare the financial resources of the companies with which we were working with those that were not participating. However, it is possible that companies that are able to survive in an increasingly competitive global environment are those that have strong financial management. This limits our ability to draw conclusions about financially less stable companies.

CONCLUSION

The small-business sector remains an underserved entity in terms of occupational health services and research. Researchers and policymakers are constantly in search of interventions and policies that work and have proven to be effective in improving workplace health and safety.

These data imply that small businesses are capable of implementing occupational health and safety programs independent of their financial status. Low-cost measures such as safety committees and safety-suggestion systems have the potential to positively impact health and safety. The data also indicate that non unionized small businesses are more prone to unsafe work practices when compared with unionized businesses.

Both policymakers and intervention researchers need to be cognizant of these findings, as they provide a foundation for the development and implementation of cost-effective interventions and policies to improve health and safety in the small-business sector.

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