Factors That Influence Safety Performance of Specialty Contractors

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Abstract: In the construction industry specialty contractors perform most of the construction work. Given their impact on the industry, the safety performance of specialty contractors should be of concern to the construction industry. This paper describes a study conducted to identify factors that significantly influence the safety performance of specialty contractors. The study was composed of separate surveys of three different specialty contractor populations—a variety of trade contractors located primarily in southern Nevada, roofing contractors in the state of Florida, and the regional offices of a large, nationwide mechanical contractor. While there appeared to be contradictions between the surveys in some areas, the study concluded that specialty contractor safety performance was consistently influenced, in part, by a number of factors. The factors shown to positively affect safety performance include minimizing worker turnover, implementing employee drug testing with various factors initiating the testing, and training with the assistance of contractor associations. Safety incentive programs were not necessarily associated with better safety performance. Growth in company size was found to be associated with improved safety performance as well.

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Introduction

The focus of many studies involving the construction industry has been on general contractors, construction management firms, and design/build firms. There are perhaps many reasons for this, but the reality is that specialty contractors, often working as subcontractors, perform most construction actually put in place. This is especially true of residential projects (Whitten 1991). Some commercial contractors are known to subcontract virtually all of their work. With the significant role played by specialty contractors, it is often puzzling that these firms are not included in more construction research studies. There may be several reasons for the lack of greater focus on specialty contractors in construction research studies. Specialty contractors tend to be small firms, although a few have quite sizable annual revenues. The work of many specialty contractors tends to be restricted to specific geographic regions, although there are also a few firms that operate on a nationwide basis.

This trend regarding construction research is also apparent in regard to research that pertains to construction safety. Despite the lack of much research emphasis on specialty contractors, the safety performance of this sector of the construction industry should be better understood. There is a need to understand what specialty contractor practices contribute most significantly to the health and welfare of workers. The intent of this paper is to present the results of a study of the safety practices of specialty contractors.

Literature Review

Specialty contractors were the specific focus of one construction safety study funded by the Construction Industry Institute (CII). The emphasis of the study was to consider the safety performance of specialty contractors as influenced by the general contractor (GC) or construction management (CM) firm. The study revealed that project size was a factor that appeared to impact the type of influence that general contractors and CMs had on the safety performances of specialty contractors. It was revealed that on large projects, subcontractor safety performance was affected to a large extent by the actions of the general contractor or CM.

The CII study found that on large projects subcontractor safety was influenced by the quality of the scheduling and coordination effort of the general contractor or CM, and the degree of emphasis placed on safety by the GC or CM. Better safety performances were noted when the GC or CM provided a full-time project safety director, discussed safety at coordination meetings and prejob conferences, monitored project safety performance, insisted on full compliance with the safety regulations, and had top management involvement in project safety. On medium-sized projects, the safety performance of subcontractors was found to be most influenced by keeping project pressures (primarily related to cost and schedule) under control and by providing effective project coordination. In addition, but to a lesser extent, it was found that subcontractor safety was influenced by the general contractor's emphasis on safety, the concern about the workers, and compliance with the safety regulations.

The CII study concluded that subcontractor safety, as a general rule, appeared to be influenced more by the general contractors than by the subcontractors themselves. This highlighted the im-

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Table 1. Annual Volume of Nevada Specialty Contractors

Response	Number of replies	Median injury rate
Less than $5 million	16	16.82
$5 million and more	22	10.45

Note: Correlation coefficient=−0.21; level of significance=0.03.

portance of the role played by general contractors and CM firms in the safety performance of subcontractors (Hinze and Figone 1988; Hinze and Talley 1988; Hinze 1997).

Research Methodology

In 1999, CII sponsored a study in the area of construction safety. This research was to identify those practices that are particularly effective in helping firms pursue the goal of zero injuries. The major effort in this research study was focused on the practices of large general contractors (the ENR Top 400), large construction projects (projects valued from $50 million to $600 million), and smaller construction firms.

The study of safety among smaller firms was supported by the CII and by funds provided by the National Institute for Occupational Safety and Health. This study was designed to be a mailed survey. The survey consisted of a three-page questionnaire that inquired about company or project demographics and various safety practices that are in place at the project level.

This study of safety in smaller firms included three separate surveys that were conducted essentially in the same manner. The first survey consisted of a mailed questionnaire that was sent to the members of the Associated General Contractors and Associated Builders and Contractors located primarily in southern Nevada. While general contractors were also included in the respondents to this survey, only the data related to specialty contractors or subcontractors are presented here. The second survey consisted of a questionnaire mailed to the roofing contractors who were members of the Florida Roofing, Sheetmetal, and Air-Conditioning Contractors Association. The third survey consisted of a questionnaire that was completed by project representatives of the regional offices of a large mechanical contractor with offices in many states. From these surveys it should be evident that three different types of samples were evaluated. The Nevada survey included specialty contractors involved in various types of trades or specialties. The Florida survey consisted of roofing contractors in the state of Florida. The mechanical contractor survey consisted of responses provided by personnel employed by the same contractor.

Table 2. Various Measures of Roofing Company Size

Measure of company size	Number of replies	Median injury rate
(a) Annual revenues[a]		
Less than $2 million	20	5.00
$2 million and over	16	16.57
(b) Projects done per year[b]		
Less than 100	14	10.96
100 or more	19	17.39
(c) Number of employees[c]		
Less than 20	20	5.00
20 or more	16	15.84

[a]Correlation coefficient=0.28; level of significance=0.01.
[b]Correlation coefficient=0.16; level of significance=0.10.
[c]Correlation coefficient=0.25; level of significance=0.02.

Table 3. Various Measures of Mechanical Contractor Project Size

Measure of region size	Number of replies	Median injury rate
(a) Annual revenues[a]		
Less than $4 million	22	5.84
$4 million and over	16	8.30
(b) Number of employees[b]		
Less than 40	25	6.35
40 or more	14	8.30
(c) Projects in progress[c]		
Less than 20	24	5.63
20 or more	15	13.33
(d) Worker hours worked[d]		
Less than 50,000	16	4.65
50,000 or more	23	11.43

[a]Correlation coefficient=0.16; level of significance=0.09.
[b]Correlation coefficient=0.22; level of significance=0.03.
[c]Correlation coefficient=0.20; level of significance=0.05.
[d]Correlation coefficient=0.22; level of significance=0.03.

Measure of Safety Performance and Data Analysis

In the three surveys, a consistent measure of safety performance was utilized. The questionnaire asked the respondents to provide information about the number of Occupational Safety and Health Administration (OSHA) recordable injuries sustained in the past year. Also, the respondents were asked to provide the number of worker hours that were worked in the past year. From this information, it was a simple matter to compute the OSHA recordable injury incidence rate—hereinafter referred to as the injury rate, reflecting the number of OSHA recordable injuries sustained per 200,000 h of worker exposure.

The data from the three surveys were analyzed separately. This was deemed essential, since the injury rates of the different sample populations were not the same. For example, for the Nevada specialty contractors the median injury rate was 11.46, for the Florida roofing contractors the median injury rate was 12.21, and for the mechanical contractor it was 9.59. Note that the industry averages of the OSHA recordable injuries in 2000, as reported in OSHA's Website, were 8.5 for specialty contractors; 10.9 for roofing, siding, and sheet metal work; and 9.2 for plumbing, heating, and air-conditioning (http://www.osha.gov/oshstats/

Table 4. Proportion of Employees with Roofing Company for More Than One Year

Response	Number of replies	Median injury rate
Less than 75%	17	11.92
75% or more	18	8.10

Note: Correlation coefficient=−0.22; level of significance=0.04.

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Table 5. Turnover Rates for Roofing Companies

Response	Number of replies	Median injury rate
Less than 50%	16	4.35
50% or more	19	17.39

Note: Correlation coefficient=0.30; level of significance=0.01.

work.html). While differences are apparent when comparing the sample statistics with the industry averages, the general magnitude of these values is similar.

For each survey, a simple correlation (Kendall's rank correlation τ) test was conducted to determine which safety practices were associated with better safety performance. The findings being reported from this study are those in which the level of statistical significance was less than 0.05. Also reported are findings that represent a trend, including those with a level of statistical significance between 0.05 and 0.10.

Results

Of the three respondent groups, the Nevada contractors group was the largest in size. There were 46 specialty contractor respondents having annual revenues ranging from $100,000 to over $600 million (median of $5 million) and the median number of employees consisted of approximately 40 employees. Of these contractors, 53% operated as open shop contractors and 47% operated as union shop contractors.

A typical roofing contractor had $1.75 million in annual revenues, ranging from about $100,000 to over $140 million. Of the 102 roofing contractor respondents, a typical firm had three projects in progress at one time and about 100 projects undertaken per year. A roofing contractor can be typified as having about 20 employees and operating under an open shop.

The same parent firm employed all of the mechanical contractor respondents and operated as an open shop firm. There were 102 field office respondents. The volume of business ranged from less than a half million dollars to nearly $50 million. A typical field office had 20 projects in progress at one time and employed about 35 workers.

Many of the respondents' questionnaires contained missing information. This was unfortunate, especially when the missing data related to information needed to compute the OSHA recordable injury rate. Since many questionnaires were returned anonymously, there was no practical means by which the missing information could be retrieved or restored.

The findings of the three different surveys are presented in a combined fashion. In this way, it is a simple procedure to present similarities between the findings of the surveys.

One finding that showed a relationship with the injury rate in all three surveys related to size. These results are shown in Tables 1, 2, and 3. For the Nevada specialty contractors, injury rates were lowest among the larger firms. For the Florida roofing contractors and the nationwide mechanical contractor, the results showed a lower injury rate among the smaller entities. Within each population, the findings are consistent for several measures of size. It should be noted that size is not a variable that can be easily manipulated. There is no obvious explanation as to why size has this impact. One could conjecture that larger firms, as in the case of the Nevada contractors, have more formalized safety practices in place. The Nevada contractors tended to be larger than the roofing contractors and the regional offices of the mechanical contractor of the Nevada contractors, 37% had full-time safety officers. The formality of the safety programs could not be ascertained with great assurance in this study.

Table 6. Turnover Rates for Mechanical Contractor

Response	Number of replies	Median injury rate
Less than 20%	13	5.93
20% or more	13	8.89

Note: Correlation coefficient=0.16; level of significance=0.09.

Table 7. Proportion of Roofing Company Projects with Private Owners

Response	Number of replies	Median injury rate
Less than 90%	14	15.84
90% or more	22	9.85

Note: Correlation coefficient=−0.26; level of significance=0.02.

Turnover and Safety

Employee turnover was examined in this study. Findings of interest were noted in the surveys of roofing contractors and the mechanical contractor. The first finding in the roofing contractor survey had only an indirect relationship to turnover. The respondents were asked what percent of the current workforce had been with the firm for more than one year. For the roofing contractors, approximately half of the contractors stated that at least 75% of their employees had been with the firm for the past year. The findings show that these are also the firms with the better safety records (Table 4). For the eight firms that reported that over 90% of their workers had been with the firm for over one year, the median injury rate was 0.00.

One survey question asked about the number of employees that had been hired within the past year (number of W-4s filed within the past year). The respondents also provided information on the number of employees normally employed at one time. From this information, it was possible to compute a value representing an approximation of the turnover rate. If a firm normally employed 40 workers and had filed 40 W-4s in the past year, the turnover rate was determined to be 100%, or a new employee was hired for each employee normally employed. Naturally, this does not mean that every worker was replaced within that time period. These numbers could include 20 employees who were employed for only a month or so. Information was not obtained on the nature of the dismissals or reasons for employees quitting their employment with the firm.

The results are quite intuitive, in that the higher turnover rates are associated with the higher injury rates. Higher turnover means more new hires on the job. New hires have been noted as the

Table 8. Nevada Specialty Contractors and Incentive Programs

Response	Number of replies	Median injury rate
Companies having safety incentives	14	11.33
Companies having no safety incentives	27	14.04

Note: Correlation coefficient=0.18; level of significance=0.08.

Table 9. Roofing Companies and Incentive Programs

Response	Number of replies	Median injury rate
Companies having safety incentives	17	17.39
Companies having no safety incentives	19	9.52

Note: Correlation coefficient=−0.36; level of significance=0.01.

workers who are most susceptible to being injured (Hinze 1997). As a result, it is common for greater attention to be paid to the newly hired workers in order to ensure their safety (Hinze 1978, 1990).

In the roofing contractor responses, it was noted that several firms reported turnover rates of more than 100%. The median injury rate was 18.86 for the firms with turnover rates of more than 100% (Table 5). For the mechanical contractor, the median turnover rate was about 20%. This low turnover rate may explain why the mechanical contractor enjoyed a lower injury rate than the typical roofing contractor. It should be noted that while there is a tendency for the higher turnover to be associated with a higher injury rate, the findings are only indicative of a trend (Table 6).

Type of Owner

While similar questions were asked in each of the surveys, it was only in the survey of roofing contractors that the type of owner was a significant factor. The results showed that firms that did the preponderance (90% or more) of their work for private owners had better safety records (Table 7). Upon first review of these findings, one might infer that it is safer to work for private owners than to work for public owners. The data were examined further to determine if this was the case. It was discovered that the roofing contractors who did more than 75% of their work for public owners had a median injury rate of 12.84, a level of safety performance that is reflective of the entire sample. The injury rate appears to be highest among those firms that do a mix of both public and private work. For example, the median injury rate was 66.67 for the three contractors that reported that more than 25% and less than 75% of their work was for public owners. This result cannot be easily explained.

Safety Incentive Programs

Of the various types of safety initiatives that companies utilize to promote worker safety, perhaps the most widely implemented type of program involves safety incentives. This is also one of the most controversial topics in the area of construction safety. Some safety professionals question the value of safety incentives, claiming that they do not actually alter worker actions. This stems from the fact that incentives are generally awarded depending on whether a worker or crew is involved in an injury accident. Under this type of program, it is evident that workers could work in an unsafe manner but still receive the incentive award if they were not involved in an injury accident.

The results from this study were interesting, in that the results from the Nevada survey and the Florida survey showed that incentives were associated with differences in injury occurrence (Tables 8 and 9). Unfortunately, the findings of these two studies are contradictory. The Nevada survey showed that companies with safety incentives had better safety records, although the findings are only indicative of a trend. In the Florida roofing contractor survey, the results show that the safer contractors are those that do not have safety incentive programs. It should be noted that the results of the Florida survey are much stronger. Since the Florida survey is taken from a much more homogeneous sample, one might conclude that incentives in Florida roofing contracting firms have questionable value in regard to impacting safety performance.

Table 11. Random Drug Testing by Nevada Specialty Contractors

Response	Number of replies	Median injury rate
Companies doing random drug testing	15	9.61
Companies not conducting random drug testing	16	11.64

Note: Correlation coefficient=0.21; level of significance=0.08.

Drug Testing

Drug testing has been a well-established program within most large construction firms for the past 10 years. Many of the smaller firms, though, established their drug testing programs in the past few years and a few still do no drug testing. In the Nevada survey, it was noted that only four respondents did not have a drug testing program (Table 10). The median injury rate for these contractors was 14.71, considerably higher than the injury rate reported by the firms with drug testing programs.

There were no other results that indicated whether drug testing programs had an impact on safety performance. There were more specific findings about particular types of drug testing that were of interest. These are shown in Tables 11, 12, 13, and 14. For the Nevada specialty contractors, safer performances were reported by those firms that stated that they conducted random drug tests in the firm and conducted follow-up drug testing. Follow-up testing may be warranted for workers who have returned to work after having been suspended or after returning from a rehabilitation program.

For the Florida roofing contractors, the drug tests that were associated with better safety performance were those conducted for reasonable cause (Table 13). These are tests that are deemed necessary because of a worker's appearance or demeanor that suggests drug abuse. It should be noted that only a few firms did not conduct tests for reasonable cause, but these had a particularly high median injury rate.

Table 10. Nevada Specialty Contractors with Drug Testing Programs

Response	Number of replies	Median injury rate
Companies doing drug testing	30	9.94
Companies not doing drug testing	4	14.71

Note: Correlation coefficient=0.25; level of significance=0.04.

Table 12. Follow-up Drug Testing by Nevada Specialty Contractors

Response	Number of replies	Median injury rate
Companies doing follow-up testing	5	5.78
Companies not conducting follow-up testing	32	11.59

Note: Correlation coefficient=0.28; level of significance=0.02.

Table 13. Drug Testing for Reasonable Cause in Roofing Companies

Response	Number of replies	Median injury rate
Companies testing for reasonable cause	20	10.37
Companies not testing for reasonable cause	4	39.29

Note: Correlation coefficient=0.26; level of significance=0.07.

Table 14. Mechanical Contractor and Postaccident Drug Testing

Response	Number of replies	Median injury rate
Division conducts postaccident tests	26	3.06
No postaccident tests conducted	13	13.33

Note: Correlation coefficient=0.24; level of significance=0.05.

The practices and policies of the mechanical contractor were suspected as being consistent between the various regional offices. Although this was true for most drug testing practices in the firm, there were a number of projects that did not regularly conduct postaccident drug tests. Those that did not conduct postaccident drug testing had significantly higher injury rates (Table 14).

Worker Training

It is widely accepted in the construction industry that training plays an important role in worker safety. Worker training typically begins with worker orientation and continues as workers need to become more informed about certain aspects of the work they are doing. These additional training sessions may include topics such as confined space entry, hot work, traffic control, lockout/tagout procedures, and a wide assortment of other topics, whether to introduce new information or merely to provide a refresher on a subject.

The results of these surveys did not yield any information on the value of worker orientation or on additional classes. Instead, the information dealt more with the manner in which the training was provided. For example, in the mechanical contractor survey it was shown that better safety records were realized when the routine training was provided by in-house personnel (Table 15). This is not a particularly strong finding, but it does indicate that in-house personnel may have a better sense of the type of training that is needed and they may be more committed to doing this task well.

Table 15. In-house Personnel Doing Training for Mechanical Contractor

Response	Number of replies	Median injury rate
In-house personnel performing safety training	24	3.65
Others performing safety training	9	13.33

Note: Correlation coefficient=0.20; level of significance=0.10.

Table 16. Nevada Specialty Contractor Trade Associations As Valued Resource on Safety

Response	Number of replies	Median injury rate
Associations valued as a resource	25	9.67
Associations not valued as a resource	15	15.345

Note: Correlation coefficient=0.27; level of significance=0.02.

Table 17. Florida Roofing Trade Association (FRSCA) As Valued Resource on Safety

Response	Number of replies	Median injury rate
Association is valued as a resource	21	7.41
Association is not valued as a resource	15	16.00

Note: Correlation coefficient=0.26; level of significance=0.03.

Role of Contractor Associations

There are many different contractor associations and there are many different services that they provide. A few questions were asked about the role of these contractor associations in the area of safety training. Surprisingly, all three surveys revealed similar results. The Nevada survey and the roofing contractor survey showed that safety performance was better among those firms that regarded their contractor association as a valued resource for safety training (Tables 16 and 17). Contractor associations often have magazines and newsletters that provide trade-specific information to the members. Some associations also develop craft-specific safety training materials for their members. Regardless of the type of information that is developed, it is apparent that there is value in the service that is realized through reduced injury rates.

The contractor associations were also found to be important to the safety performance of the projects of the mechanical contractor, but the influence of the associations was imparted differently. It was found that the safer projects were those where the trade associations actually provided or delivered some of the safety training (Table 18). The survey did not determine the type of training actually provided—only that the associations were integrally involved in delivering the safety training.

Safety Inspections

Safety inspections are one means by which project managers and site supervisors can become acquainted with the nature of the safety conditions on-site. There were no unique findings that indicated that these inspections reduced accidents. However, there was one finding in the mechanical contractor survey that showed that projects had better safety records when the forepersons actually conducted the jobsite safety inspections (Table 19). While the findings are not particularly strong, the results indicate the value of line supervision being directly involved in project safety.

Summary and Conclusions

The three surveys conducted as part of this study were focused on specialty contractors. In several areas there were some interesting parallels between the surveys, and in other areas there appeared to be contradictions. In regard to the size of the company or regional

Table 18. Mechanical Contractor Use of Contractor Associations

Response	Number of replies	Median injury rate
Associations conducting safety training	9	3.92
Associations not conducting safety training	24	10.33

Note: Correlation coefficient=0.26; level of significance=0.05.

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Table 19. Forepersons of Mechanical Contractor Conducting Jobsite Safety Inspections

Response	Number of replies	Median injury rate
Forepersons conducting safety inspections	15	5.33
Forepersons not conducting safety inspections	11	11.43

Note: Correlation coefficient=0.22; level of significance=0.10.

office, two surveys showed that the injury rate increased with size, but there was an opposite finding in the Nevada survey. Other research has tended to support the theory that for small firms or projects the injury rate increases with size, but that this rate decreases with size once the size is sufficiently large to warrant implementation of a formalized safety program (Hinze 1997).

In regard to two of the surveys, it was shown that injury rates increased with an increase in the turnover rate. This would appear logical, as a high turnover means a high number of new workers and these are the workers who are particularly susceptible to injury. In one of the surveys it was also found that worker retention shows a direct benefit for safety performance. Of course, worker retention is inversely related to worker turnover.

One survey showed that safer worker performances were realized among those firms reporting that a large percentage of their projects were with private owners. Further analysis showed that it may not necessarily be the fact that more private work is being done, but that more injuries are noted when there is a stronger mix of both public and private projects.

Safety incentives have been the subject of criticism in recent years, and this research does not provide strong evidence to counter this view. One survey showed that incentives appeared to help reduce the injury rate, while an even stronger finding in another survey showed that incentives were not effective in reducing worker injuries. Clearly, the use of incentives is no guarantee of having a good safety record.

Most firms have some form of drug testing in place. While there was no exact agreement between the three surveys, all did show that for at least one type of drug test, injury performance was favorably impacted. These tests included random tests, tests for reasonable cause, postaccident tests, and follow-up testing. No evidence suggests that drug testing is not effective in reducing injuries.

Training must serve the needs of the employer. In one survey it was shown that this could be best accomplished with the training being conducted by in-house personnel. Other training related findings showed that firms or projects placing some reliance on the contractor associations for assistance in training had better safety performances. Finally, one survey showed that jobsite safety inspections by the forepersons were helpful in terms of reducing worker injuries. The findings do indicate that there are at least some common issues between the different studies that point to ways of achieving better safety performance.

Recommendations

The research findings provide some valuable guidance to specialty contractors. Findings suggest that turnover should be minimized, drug testing should be implemented with various factors initiating the testing, training should be conducted with the assistance of the contractor associations, and safety incentives should be employed with caution. While the findings involving incentives were not consistent, it is obvious that incentives are not a guarantee of good safety performance. The findings also suggest that growth may be associated with an increase in the injury rate. This growth must be accompanied with the formal introduction of safety program elements that have been shown to be effective in ensuring jobsite safety.

The results of this study involving specialty contractors are encouraging; however, they are largely inconclusive. That is, the findings are not sufficiently compelling that they can be universally applied to all specialty contractors. A research study involving a larger sample is suggested. Such a study should have a sample that is large enough such that the data could be examined for the unique effects on safety of the practices of firms involved in only one specialty area. While it is suspected that the findings will show consistency across several specialty areas, this must be determined in such a study.

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