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Safety Performance of Subcontractors in the Palestinian Construction Industry

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Abstract: Subcontractors perform most of the construction works and their effect on industry are apparent in different activities of construction. Therefore, subcontractors need more attention from government and contractors union. The aim of this paper is to identify, evaluate, and rank factors that influence safety performance of subcontractors in the Gaza Strip (Palestine) according to their relative importance. The study concluded that reported accident rates will decrease among subcontractors and their workers if new workers are trained well in the work site and they are informed about dangerous places, and if a workable safety plan is well preplanned. The results also showed that reported accident rates increased among subcontractors when using old, unsafe equipment and due to the complexity or difficulty in the construction sites features. Owners and general contractors need to stipulate strict clauses for safety in the contract for improving safety record of subcontractors. Construction workers must receive proper job related safety and health training with a safety logbook. It is recommended that the subcontractors and workers should attend continuing safety programs on regular basis as part of their perquisite to work in construction sites.

Keywords: Safety, Subcontractors, Performance, Injuries

INTRODUCTION

Construction industry is a very important sector of economy in developing countries. It encounters very complex practices, which includes: owners, general contractors, specialist contractors, suppliers and designers. Safety performance is a very sensitive matter; it deals with human life, the active resource in all aspects of life and its continuity (Larcher and Sohail, 1999). For the most part, the construction industry thrives on the work of subcontractors. On building construction projects, it is common that 80–90% of the work is to be performed by subcontractors. On highways or other infrastructure projects, the portion subcontracted is generally less but a significant amount of the work is still performed under subcontract agreements (Hinze, 1997).

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Construction relies heavily on subcontractors and their workers who are employed by prime contractors. Subcontractors are the wheels which carry the project to completion (Shimizu and Cardoso, 2002) and therefore, are the dynamic of the construction industry. The quality of subcontractors is significant as it has a direct bearing on how well tasks are performed for the general contractors. The construction industry relies heavily on specialised subcontractors to bring the expertise needed for specific jobs. As a result, the quality of specialist subcontractors is even more important because it has a direct bearing on the performance of the prime contractor on key elements of the work (Sohail, 1999). Whitten (1999) stated that the focus of many studies in the construction industry was on general contractors, construction management firms, and design/build firms. There are perhaps many reasons for this, but the reality is that specialty contractors actually execute most construction on-site while working as subcontractors (Hinze and Gambatese, 2003; Fang et al., 2004).

In Palestine, the key players in the construction industry do not adopt safe working practices for several reasons including that: employers and employees are unwilling to spend or invest in safety measures, equipment or practices; hazards are considered a necessary part and consequence of construction; employees cannot afford to purchase their own safety equipment (e.g., safety shoes) and fear they might be penalised if they request personal protective equipment (PPE) from their employers. Additionally, contractors are not aware of their legal responsibilities in relation to health and safety issues. Thus, the objective of this study is to identify, evaluate, and rank factors that influence the safety performance of subcontractors according to their relative importance, as perceived by respondents.

LITERATURE REVIEW

The US construction industry currently accounts for over 22% of all occupational fatalities although it employs less than 7% of the US workforce (Loushine et al., 2003). Koehn et al. (1995) stated that in developing countries, statistics are not available on the level of accidents and fatalities. Based on data available from the UK and the level of legislation and/or hazard awareness, it is reasonable to assume that there is a serious health and safety problem in developing countries (Koehn et al., 1995). In many countries, the legislation governing health and safety is significantly limited when compared with the UK. There are rarely any special provisions for construction in worker's safety and the general conditions for workers are often not addressed. In many countries where safety legislation exists, the regulatory authority is very weak or non-existent; many employers will only "pay lip service" to the regulations (Lee and Halpin, 2003). There have been cases reported

where first aid kits are provided on site "for show" and never used by injured workers. Injuries are often not reported and the employer provides some form of cash compensation for an injury to the employee (Koehn et al., 1995).

On-site accidents occur because the real hazards were either not perceived or were perceived to be less dangerous than they actually were (Sohail, 1999). Sikes et al. (2000) stated that the selection of subcontractors is crucial to both the safety and success of a project. This selection-for-safety practice may eliminate subcontractors with the lowest bid, and who do not have satisfactory safety record. Subcontractors with a poor history of safety performance are eliminated and subcontractors who enforced safety program are selected (Bertagnoli, 2002).

The trend in recent years has been towards greater prime contractor's responsibility for subcontractor's performance in ensuring overall project safety. The justification for this trend is that, on typical construction projects, it is imperative that safety be uniformly and consistently emphasised by all contractors on the site and that the same safety and health policies and procedures are enforced across the site. Prime contractors are increasingly reviewing safety records and programs of subcontractors before contracting with them. In some cases, the prime contractors are developing a project-specific safety plan that is binding on all subcontractors working on the project.

In other cases, the prime contractor conducts weekly safety talks with representatives of the various subcontractors to monitor work crews especially their site safety. Another approach is to involve the prime contractor in conducting frequent daily and weekly inspections of subcontractor's work areas and stopping work if serious deficiencies are identified (Worker Protection Programs in Construction, 1994). There may be many factors that affect the safety performance of subcontractors working on construction sites, and this study is designed to find the relative importance of critical factors in improving the safety performance of subcontractors in construction site environments.

METHODOLOGY

This paper is based on qualitative and quantitative approaches. Qualitatively, 30 factors that influence safety performance of subcontractors have been identified based on the knowledge obtained from literature review (Hinze, 1997; Sohail, 1999; Whitten, 1999; CII, 1990) and consultation with key local experts. Quantitatively, 60 questionnaires were distributed to randomly selected

subcontractors to get their opinion about the influence of the identified factors on their safety performance on a five-point Likert scale. Thirty-four questionnaires were returned and completed with response rate 56% for quantitative analysis.

To determine the ranking of the different factors that influence safety performance of subcontractors, the "Relative Importance Index" (RII) was adopted. This method transforms the five-point Likert scale mentioned earlier to determine the ranking of each factor using the following expression:

$$RII = \frac{\sum_{i=1}^{5} a_i x_i}{5 \times N}$$

Where a_i is a constant expressing the weight of the i^{th} response, x_i is the frequency of the i^{th} response of the total responses for each cause, i is the response category index where i = 1, 2, 3, 4 and 5 respectively, N is the total number of respondents. RII value is ranged from 0 to 1 (Tam et al., 2000, cited in Tam et al., 2004).

RESULTS

The factors that lead to a decrease in the injury rate will be discussed (see Table 1) followed by the factors that lead to an increase in the injury rate will be analysed (see Table 2).

FACTORS DECREASING INJURIES

The injury rate decreases among subcontractors and their workers if new workers are well-trained on the work site and informed about dangerous places, this is ranked as the most important factor with RII of 0.89. The significance of this factor is related to the labour force that performs all construction activities on-site. Safety training of new workers reflects that general contractors are willing to train their workers before they start work on-site. These training activities that foster safe practices may result in reduced damage to both material and equipment. Workers' training begin with orientation and informing workers about dangerous places and helping them to become familiar with the job site. Training should also continue after the workers become skilled.

Table 1. Ranking of Factors that Decrease the Injury Rate for Subcontractors

Factors Decreasing the Injury Rate	Strongly Agree (1)	Agree (2)	Average (3)	Disagree (4)	Strongly Disagree (5)	R.I.I	Rank
The injury rate decreases among subcontractors and their workers if new workers are trained well on the work site and informed about dangerous places.	5	20	11	2	1	0.89	1
The injury rate decreases if a workable safety plan is well preplanned.	15	15	4	0	0	0.86	2
The injury rate decreases among subcontractors if a safety officer is hired.	16	13	3	1	1	0.85	3
The injury rate decreases among subcontractors and their workers if new workers are trained with other experienced colleagues on the work site.	14	15	4	1	0	0.85	3
The injury rate decreases among subcontractors when safety and health is included in general contractor's priorities.	10	18	6	0	0	0.82	5
The injury rate decreases among subcontractors and their workers if supervisors and foremen are well trained.	12	17	2	2	1	0.82	5
The injury rate decreases among subcontractors if official inspection is applied.	10	19	2	3	0	0.81	7
The injury rate decreases among subcontractors if the contract between the general contractor and the employer stipulates a specific amount for safety during bidding.	9	19	5	1	0	0.81	7
The injury rate decreases among subcontractors if the general contractor is deprived of contracts for a limited period for being negligent in applying safety and health regulation and rules.	12	16	3	2	1	0.81	7
The injury rate decreases among subcontractors if strict laws and penalties, such as dismissal and discount, are applied against illegal workers and specialist contractors .	13	11	8	2	0	0.81	7
The injury rate decreases among subcontractors if general contractor gives the work to professional specialist contractors with clean records of safety.	8	21	3	2	0	0.81	7
The injury rate decreases among subcontractors due to motivation based on compliance with safety regulation and rules.	11	15	5	3	0	0.80	12
The injury rate decreases among subcontractors when safety and health is included in owner priorities.	10	14	9	1	0	0.79	13
The injury rate decreases among subcontractors if safety guidance and orientation facilities are spread among workers and specialist contractors.	6	17	10	1	0	0.76	14
The injury rate decreases among subcontractors when their presence on site is scheduled so as to avoid creating any build up on site.	5	11	13	4	1	0.69	15

The injury rate decreases if a job specific safety plan is well preplanned. This factor has been ranked by the respondents in the 2nd place with RII = 0.86. Safety plans are to include hazard analysis in accordance with site conditions and nature of the construction activities. The effect of safety planning is apparent where precautions are considered before starting any activity by analysing the hazards associated with each activity. Nonetheless, a site safety plan should be reviewed before the project starts and needs to be modified during performance of the construction activities.

The injury rate can decrease if a safety officer is hired. This factor has been ranked by the respondents in the 3rd place with RII = 0.85. A safety officer provides more confidence and assurance to workers and subcontractors that the workplace can be made a safer place. A safety officer's authorisation gives him an important role to play in checking for illegal workers and for where specialist contractors use unsafe work practices. Nonetheless, in Palestine, a safety officer is rarely hired for a construction project. On small size projects it is generally not realistic to employ a full time safety officer, and so the construction manager must be prepared to take on this responsibility.

The injury rate decreases among subcontractors and their workers if new workers are trained with other experienced colleagues at the work site. This factor has also been ranked in the 3rd place. The respondents believed that it is vital for new workers to be involved directly in working together with more experienced partners.

The injury rate decreases when safety and health clauses are considered a priority for general contractors. This factor was ranked 5th with RII = 0.82. This factor reflects the general contractor's role in safety performance and his ability to control others to fulfill their obligations to uphold safety rules and regulations. The central impact of the general contractor on implementing health and safety clauses in the contract is obvious because he has a direct relationship with the specialist contractors. If safety has a high priority for the general contractor, the benefits will soon become apparent.

The injury rate will decrease among subcontractors and their workers if the supervisors and foremen are well-trained. This factor was also ranked 5th. Well-trained supervisors and foremen demand high standards of safety and health amongst site crews and specialist contractors. Supervisors and foremen play a pivotal role in worker safety where they provide the necessary guidance in ensuring that workers are performing in a safe manner. The injury rate decreases if there are official inspections for safety. This factor has been ranked in the 7th place with RII = 0.81. Formal inspection is very important for monitoring whether

there are illegal workers on site and for ensuring that specialist contractors comply with safety rules and regulations, especially when the inspectors have a high level of authority.

The injury rate decreases if the contract between the general contractor and the employer stipulates specific pay for safety implementation. This factor has been ranked in the 7th place with RII = 0.81. Specifying safety regulation in the contract reflects the special attention that the parties to the contract pay to safety and health.

The injury rate decreases if the general contractor is denied the opportunity to win contracts for a limited period because of his negligence in applying safety and health rules and regulations. This factor was also ranked 7th. The threat of being denied the chance of winning contracts makes the general contractor interested in engaging safety-conscious specialist contractors and in excluding careless subcontractors. Consequently, the general contractor is naturally more committed to safety performance.

The injury rate decreases if strict laws and penalties such as dismissal and discount are applied against illegal workers and subcontractors. This factor was also ranked in the 7th place with RII = 0.81. The factor's effectiveness is related to the application of punishment and penalties against unsafe workers and subcontractors. The general contractor can take action against illegal workers and subcontractors to encourage them to comply with rules and regulations that lead to improved on-site safety performance.

The injury rate decreases among subcontractors if the general contractor gives the work to subcontractors with a clean safety record. This factor has an index of 0.81. It is a valuable factor to subcontractors that do maintain a clean and good safety record because it favours them for future contracts, and helps emphasise the fact that care for human health and safety are paramount.

The injury rate decreases if safety incentive programs exist. The respondents ranked this factor in the 12th place with RII = 0.80. This indicates that although incentives can play an important role in altering workers actions and helping in reducing injuries, there is no guarantee that it will lead to a good safety record. The injury rate decreases when safety and health is considered by owners as a high priority. This factor was ranked in the 13th place with RII = 0.79. Owners should consider safety an equally important priority to cost, quality and scheduling.

The injury rate decreases if safety guidance as well as safety orientation provided by the general contractor are

extended so as to include the subcontractors' employees. This factor was ranked in the 14th position with RII = 0.76. The injury rate decreases among subcontractors when their presence on site is scheduled so as to avoid creating any build up on site. This factor was ranked in the 15th position with RII = 0.69.

FACTORS INCREASING INJURIES

Table 2 illustrates the rankings of the factors that lead to increasing injury rates amongst subcontractors. The injury rate increases among subcontractors when they use old, unsafe equipment. This factor was ranked 1st by the respondents with RII of 0.85. Most accidents are caused by a combination of old, unsafe equipment and worker's actions. Physical injury often results from such accidents.

The injury rate increases when there is complexity or difficulty caused by problematic site condition. This factor has been ranked in the 2nd place with RII = 0.78. The difficulty and complexity of the site cause additional accidents, when, for example, poor soil or hidden caves occur and require specialist skills that may not be available on site.

The injury rate increases when there are strict financial constraints or harsh economic conditions. This factor was ranked 3rd with RII = 0.77. Difficult financial circumstances can have an adverse effect on safety performance, as for example, when workers or subcontractors are under pressure to accept work that must be performed under unsafe conditions.

The injury rate increases among subcontractors and their workers on large and complex projects, particularly those which require a large number of subcontractors. This factor has been ranked in the 4th position with RII = 0.76. The coordination of the various contractors is complicated and there are likely to be many situations where they have to interface on tasks, and this itself leads to further difficulties.

The injury rate increases when there is an accumulation of specialist contractors with different specialisations. This factor was also ranked 4th. The injury rate increases when a construction project needs to engage numerous specialist contractors in order to speedily complete the works at hand. Often such a build-up will cause conflicts amongst the specialist contractors especially when they are working in close proximity.

Table 2. Ranking of Factors that Increase the Injury Rate for Subcontractors

Factors Increasing the Injury Rate	Strongly Agree (1)	Agree (2)	Average (3)	Disagree (4)	Strongly Disagree (5)	R.I.I	Rank
The injury rate increases among subcontractors when using old, unsafe equipment.	12	19	3	0	0	0.85	1
The injury rate increases among subcontractors when there is complexity or difficulty appear on site.	4	22	8	0	0	0.78	2
The injury rate increases among subcontractors due to depression and hard economical situations.	13	10	5	5	1	0.77	3
The injury rate increases among subcontractors and their workers on large, complex projects, which require big numbers of subcontractors.	9	14	7	3	1	0.76	4
The injury rate increases among subcontractors and their workers due to accumulation of subcontractors in different specialisations.	7	15	10	2	0	0.76	4
The injury rate increases among subcontractors when the aware is to the low bidder.	8	13	7	4	2	0.72	6
The injury rate increases if experienced familiar workers are replaced by subcontractors with new experienced workers.	7	10	14	2	1	0.72	6
The injury rate increases among subcontractors if their workers are unfamiliar with the work site & dangerous positions.	1	18	13	2	0	0.71	8
The injury rate increases among subcontractors due to bad weather.	4	14	10	4	2	0.68	9
The injury rate increases among subcontractors when owner or employer is private firm.	3	10	11	8	2	0.64	10
The injury rate increases among subcontractors due to acceleration to implement project on time.	4	10	10	8	2	0.64	10
The injury rate increases among subcontractors due to safety expenditure and cost.	3	9	14	6	2	0.63	12
The injury rate increases if a subcontractor is replaced by another one of the same specialisation at same project.	2	8	12	12	0	0.60	13
The injury rate increases among subcontractors if owner is governmental semi-official firm.	0	7	11	13	3	0.53	14
The injury rate increases among subcontractors when project is over budget.	0	4	12	14	4	0.49	15

The injury rate increases when a low bid awarding system is used. This factor was ranked in the 6th place with RII = 0.72. Low bid awarding practice has a negative effect on safety performance where general contractors or subcontractors try to win a project solely on price and where a proven safety track-record has little or no importance. The injury rate increases if experienced workers are replaced with new untrained workers by the subcontractors. This factor was also ranked in the 6th position with RII of 0.72.

The injury rate increases among subcontractors if their workers are not well aware of the work tasks that are required and the associated hazards. This factor was ranked by the respondents in the 8th position with an RII of 0.71. This makes sense as workers unfamiliar with the work conditions must be at higher risk of injury on a construction site.

The injury rate increases among subcontractors when there is bad weather. This factor was ranked in the 9th position with RII = 0.68. This factor has a medium effect on increasing the injury rate, probably because the weather in Palestine is not extreme. The injury rate increases among subcontractors if the owner is a private organisation. This factor was ranked in the 10th position with RII = 0.64 for increasing the injury rate. This result indicates that private organisations care too much about the delivery of their project and too little about safety issues.

The injury rate increases among subcontractors when there is a need to accelerate to complete the project on time. This factor was also ranked in the 10th position with RII = 0.64. Acceleration of activities is likely to cause some problems and unsafe work conditions that may result in accidents. However, if acceleration is occurring towards the end of the project it is less likely that it will be dangerous.

The injury rate increases among subcontractors when there is less safety-related investment. This factor was ranked in the 12th place with RII of 0.63. In Palestine, safety investment is relatively low due to the lack of safety culture. The injury rate increases if one subcontractor is replaced by another on the same project. This factor was ranked in the 13th position by the respondents with RII = 0.60. This factor is fairly insignificant because it is very difficult within the construction industry to replace a subcontractor on a job, except in very rare cases.

The injury rate increases among subcontractors if the owner or employer is a governmental or semi-official organisation. This factor was ranked in the 14th position by the respondents with RII of 0.53. This factor was

ranked very low as safety performance on governmental projects is generally better controlled than on private projects. Additionally, safety investment is relatively high on public projects as compared to that of the private ones. The injury rate increases among subcontractors when the project is over budget. This factor has the last rank in factors with RII of 0.49. Subcontractors seem often not to be affected when the project is over budget.

CONCLUSION AND RECOMMENDATIONS

The construction industry plays a vital role in the Palestinian national economy. Subcontractors provide economic flexibility and technical expertise to the construction industry and it felt imperative to investigate safety performance of subcontractors in the Gaza Strip. This study indicated that the injury rate decreases among subcontractors and their workers if new workers are trained well in job tasks and are informed about job risks and associated hazards. Furthermore, a workable preplanned site safety plan is required to reduce accident rates. The injury rate increases when subcontractors use old, unsafe equipment, and also when the job has complex and difficult features. It is interesting to note that although incentives may play an important role in altering workers' actions and help in reducing injuries, there is no guarantee that they will lead to a good overall safety record. Financial constraints and hard economic circumstances have a critical effect on safety performance because it may lead workers and subcontractors to accepting work under unsafe conditions.

Modern construction industry requirements are that subcontractors and their workers must change their attitudes towards safety behaviour and site conditions. All construction industry stakeholders have a responsibility for improving or upraising safety performance on site. Results indicate that training, contract items, safety plans, motivation, safety rules and regulations, hiring of safety officers, avoiding worker turnover and worker replacement are the important elements for improving site safety. Owners and general contractors have to stipulate in their contracts with subcontractors an amount that must be set aside for safety training, personal protective equipment and other preventive measures.

Construction workers must receive proper job-related safety and health training with a safety logbook. Workers must be required to fill in the safety logbook to reflect their contribution towards site safety, as well as for using the record to improve their safety performance. The study recommends that hiring a safety officer is critical if safety performance is to be improved, however, employing a safety officer either part-time or full-time must depend upon the work volume. General contractors have to keep

full details of the safety records of specialist contractors as this should have impact on their suitability for future subcontracted works. It is recommended that subcontractors and their workers should attend safety programs regularly on site as part of their obligation to work on that site. Finally, subcontractors should be required to modernise equipment, machines and do regular maintenance if they are to help keep site operations safe.

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