Research Study of Scaffolding Accidents in Construction

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Abstract

The purpose of this research paper is to investigate the current programs directed toward increasing the safety for scaffolding which ultimately mitigates the risk of fall accidents. In the construction industry, fall accidents is one of the leading cause of serious injury or fatality. The paper will examine numerous programs around the world that are being implemented on jobsites to ensure the safety of workers who are using scaffolding. In the industry, there will always be a number of accidents but with the right prevention programs in place companies and organizations will have the ability to control the outcome of the number of accidents that occur. Along with analyzing prevention programs, the paper will discuss current regulations for scaffolding, required PPE for jobsites, and calculate the annual number of fall accidents according to OSHA.

Introduction

Scaffolding is well-known element in construction. According to Merriam-Webster Dictionary scaffolding is defines as “a temporary or movable platform for workers (such as bricklayers, painters, or miners) to stand or sit on when working at the height above the floor or ground” (Webster, 2018). The definition is limited to the number of trades that use scaffolding as a tool for construction. According to OSHA, the top standard violations includes; Fall Protection, Construction; Scaffolding, General Requirements, Construction; and Fall Protection-Training Requirements (OSHA, 2018). On the OSHA website, 29 CFR 1926.451, Scaffolding General Requirements, Construction; which state the requirements for expected load/weight on equipment, material that will be on the equipment, person who will be on the equipment, how equipment should be installed depending on type, specific distance from certain equipment, how they should be braced or tied, security and support, fall protection, PPE, etc (OSHA, United States Department of Labor, 2018). The OSHA general requirements clearly state all aspects when using equipment on jobsite.

OSHA standard, 29 CFR 1926.501, Fall Protection in Construction, which indicates when fall protection is required depending on current state of equipment, what way the scaffold is set up, height of the equipment, descriptive way on how to install fall protection depending on what field you are in the construction industry, etc (OSHA, United States Department of Labor, 2018). OSHA standard, 29 CFR 1926.503, Fall Protection-Training Requirements, state training programs for employees how have the risk of being exposed to potential fall accidents, how to inspect fall protection before using, fall protection plans, nature of the fall hazards, equipment state, after training employees will receive a certification (OSHA, United States Department of Labor, 2018).

Throughout the construction industry, PPE is a requirement which is an essential key to safety. PPE includes gloves, safety glasses, boots, earplugs, hard hats, vests, and more when required.
Scaffolding safety has the potential to increase if the workforce is properly trained on equipment along with fall protection and simply be compliant with OSHA standards. If the construction industry could implement the culture of the importance of safety on jobsite, they will benefit by decreasing the rate of potential fall accidents from scaffolding. In the literature review, there are a number of case studies that are attempting to implement different prevention programs that would tackle to current problem of injuries cased from falling on scaffolding equipment.

**Research Questions**

1. What fall prevention programs are being implemented into the construction industry decrease the risk of serious injury or fatality accidents?  
   → (In this question, I am investigating what current prevention programs are being used in the industry to decrease the fatality and serious injury rate from scaffolding. Examples; of educating the workforce, implementing incentive program, spreading awareness, thoroughly evaluating equipment, etc.)

2. What is the current fatality rate from scaffolding in the construction industry? (Year of 2017)  
   → (In this question, I am investigating the current results in terms of fatalities from scaffolding according to OSHA.)

3. When a worker is injured from a falling accident, are they wearing the proper PPE?  
   → (In this question, I am investigating when an accident occurs are the employees wearing the mandatory PPE; such as hardhat, harness, boots, etc.)

4. Which fall prevention program is the best?  
   → (In this question, I am wanting to prove which fall prevention program is the best based on results such as; serious injury & fatality statistics, workforce response, and current research.)

**Research Hypothesis**

In the construction industry, the correlation between current average rate of fall accidents and past rates is decreasing due to the involvement of companies and organizations who value the importance of worker safety on the jobsite.

**Research Method**

For this paper, the research method is to thoroughly review scholarly case studies along with articles and include statistics from the previous years on fall accidents in the construction industry. The scholarly case studies will discuss in-depth research gathered around the world in hopes to improve the scaffolding safety which will ultimately decrease the risk of fall accidents. The scholarly articles will mention the final results of the research or practice that was implemented onto a jobsite to mitigate the risk of fall accidents. The results will vary from success or a start with multiple limitations which needs to be slightly adjusted to reach maximum
opportunities to potentially decrease the high rate of fatalities or serious injuries from fall accidents specifically from scaffolding. Lastly, statistics will be mentioned in the research paper to help readers view one of the highest risk in construction industry. The end result will be proven by the results of prevention programs, statistics, and current regulations set on scaffolding safety.

**Literature Review**

A) **Characteristic Analysis of Occupational Accidents at Small Construction Enterprises;**

The scholarly article was written on the Taiwan Construction Industry. Researchers decided that the best approach to analyze the Construction Industry in Taiwan was to use methodology of descriptive statistics and ANOVA which is best known as the correlation coefficient analysis. For this research, the data used for the study was collected from Council of Labor Affairs of Taiwan Central Government which consisted of 1546 occupational accident reported in the construction industry from year 2000 to 2007. Of the 1546 accidents reported, 800 accidents were associated with small construction companies who employed an average of 10 workers or less. According to the research paper, “Taiwan Labor Safety and Health Act, a major occupational accident is defined as an accident that causes injuries to three or more persons or causes the death of at least one person at the time it occurs” (Cheng, Leu, Lin, & Fan, 2010). Cheng, Leu, Lin and Fan (2010) concluded that “causes of most occupational accidents in the construction industry are largely attributable to management negligence or inadequate worker safety awareness” (Cheng, Leu, Lin, & Fan, 2010). Management is an important factor to the way workforce is operating in the industry. They are the start point of spreading awareness to any field in the industry. If management, decides to lead with showing no importance to safety then it will negatively affect the labor force. A major conclusion for this research, small construction companies are a higher accident rate than large companies due to the following reasons; management is not qualified, safety awareness is low, tend to be non-compliant with safety regulations/laws, insufficient safety protection, protocol, and facilities. An important regulation Taiwan Labor Safety and Health Act attempts to advocate to the construction industry is to provide training for a minimum of 6 hours along with mandatory health and safety test which must be passed.

Before determining what characteristics are associated with occupational accidents among small construction enterprises, researchers created a two-way contingency table. The table gave researchers the ability to “calculate the potential factors affecting the occurrence of occupational accidents in order to explore the relationship between safety management and occupational accidents for small construction enterprises” (Cheng, Leu, Lin, & Fan, 2010). Researchers we able to create a mathematical function that would show the relationship between management and the occupational accident rate. After analyzing 800 occupational accidents, the factors included the following; health and safety management work, project jurisdiction, condition of victim, gender, project contract amount, interval between worker arrival at jobsite and accident,
unsafe condition, unsafe act, worker type, worker age, and project type. At the end of the study, Cheng, Leu, Lin and Fan (2010) the major “problems included not to value the importance of safety measures implemented on the workplaces, not to practice sufficient safety education for new workers, not to hire well-trained safety and health personnel to implement safety measures” (Cheng, Leu, Lin, & Fan, 2010). Currently, occupational accident rate is associated with problems like; proper training for workforce on safety, not expressing the importance of individual safety/health along with entire site and hiring non-compliant workforce which shows they have no prior experience in the industry. The suggested prevention program for small construction enterprises is to promote excellent health and safety management which benefit companies in the long run with their current accident rate.

B) Accident Patterns and Prevention Measures for Fatal Occupational Falls in the Construction Industry;

The scholarly article research data is based on 621 occupational fatal falls which identifies factors such as victim’s individual factors, accident site, company size, and the cause of the accident. The individual factors associated with victims are age, gender, construction experience, and the proper use of PPE, personal protection equipment. Scaffolding accidents are associated with a lack of complying scaffolds and bodily action. In the research, two prevention programs (primary and secondary) are being implemented to prevent future falls or mitigate the risk of falling which is easily adaptable to each type of accidents. The primary prevention measures handrails, guardrails, surface opening protections, crawl boards and planks, and strong roofing materials. The secondary prevention measures safety belt, safety harness, and safety nets. According to the article, “the construction industry has been identified as one of the most hazardous industries in many parts of the world and falls from height are a leading cause of fatalities in construction operations” (Chi, Chang, & Ting, 2005). Construction is known to be one of the most dangerous occupation due to the multiple reasons; operation of heavy machinery, equipment being used, materials being used, process of how to complete the project, etc.

The MLID, Manitoba Labor and Immigration Division, Fall Protection Guidelines, state six categories of fall protection measures. The six categories include; (1) surface protection, (2) fixed barriers, (3) surface opening protections, (4) travel restraint systems, (5) fall arrest systems, and (6) fall containment systems (Chi, Chang, & Ting, 2005). The following categories measure all aspects of scaffolding equipment when being used which has the capability of preventing fall accidents. The prevention program measures will help the industry prevent a number of future fall accidents just by simply analyzing the equipment.

C) Using BIM for Smarter and Safer Scaffolding and Framework Construction: A Preliminary Methodology;

The scholarly article was written on the Queensland and Australia Construction Industry. Chi, Hampson, Biggs (2012) “goal of this research project is to develop specific BIM objects for
temporary construction activities which are fully integrated with object design, construction efficiency, and safety parameters” and “the project will deliver modularized electronic scaffolding and formwork objects that will allow designers to easily incorporate them into BIM models to facilitate smarter and safer infrastructure and building construction”. Researchers aim to create temporary BIM objects which will be available for use by a number of groups during the entire construction process of any given project. The two countries believe in “harmonization.” According to Cambridge Dictionary, harmonization is defined as “the act of making systems or laws the same or similar in different companies, countries, etc. so that they can work together more easily” (Dictionary, 2018). When countries practice “harmonization” they create the ability of knowing the process because they share the same systems and laws for a given industry. So, countries are able to adapt to any given location because they use the same laws & systems to operate. The research was based on a strategic three-phase research and industry development methodology. First step, is a preliminary review on industrial scaffolding and formwork practices and BIM implementation. Second step, BIM object development with specifics to safety and productivity functions. Lastly, is the workshop which includes training and product dissemination. In the year of 2007 to 2008, there were a total of 14,760 worker comp claims which 3%, 410 claims, were considered to be scaffolding and formwork related. An equation they calculated the total cost of the number of claims that given year (Chi, Hampson, & Biggs, 2012). The equation calculates the total cost of claims by multiplying the # of claims that given year by the median payment for claims that year. The research team aims to decrease the potential risk of fall accidents on the jobsite along with improving their productivity simply by implementing BIM technology to create objects for temporary work.

The main goal to consider in the research is construction safety. Construction safety and BIM can create opportunity for design for safety, safety integrated models, structural safety analysis, on-site inspection and monitoring, safety planning, safety training, and facilitate management and emergency responses. The proposed prevention program for safer scaffolding and framework construction will benefit the construction industry by the following; “(1) enable design in accordance with safety requirements , (2) incorporate design codes, (3) design for constructability in 4D and 3D with schedule, (4) provide visualization of the installation procedure, design, and installation options and give working condition analyses, such as limited clearance with the surrounding environment, (5) enable structural safety analysis, (6) highlight opportunities for design innovation and (7) provide BIM checklists for routine on-site inspections that would benefit practical safety assessment on construction sites” (Chi, Hampson, & Biggs, 2012). Every aspect of incorporating technology with scaffolding safety is benefited. In conclusion, the future research outcome is to completely created various BIM object which is scaffolding and formwork that designers and constructors can access to use for a number of projects. The end goal is giving the ability to designers and constructors to implement a BIM object which is benefit by creating safe and efficient construction process.

D) Fall Related Deaths in the Construction Industry;
The scholarly article is based on the data retrieved from OSHA fatality inspection records. The data was used to determine the potential causes for a number of occupational falls which resulted into a fatality. According to the article, “fatal work-related falls continue to remain one of the leading causes of death in the workplace” and “fatal-work related falls continue to be a leading cause of death in the construction industry” (Janicak, 1998). As said before, the Construction Industry is a dangerous occupation which also has the highest fatality rate among all other industries. The fatality inspection records from OSHA were analyzed from 1992 to 1995. The inspection information included industry, nature of injury, accident abstract, location of fall, height, cause of fall. After the first set of information is documented, the fatality is categorized by the following; structural collapse, no fall protection presented, fall protection not attached, damaged fall protection, improper work surface, erecting/dismantling scaffolding, fall from ladder, other, and unknown. The number of fatal-work related fall in the construction industry that was examined a total of 566. In conclusion, the four prevention areas that need to be enforced employee training, the use of fall protection systems, inspection, and testing of the fall protection systems in use.

E) An Evaluation of Scaffold Safety at Construction Sites

The scholarly article was written on 113 scaffolds which were in nine areas of the eastern part of the United States. The areas included; Baltimore, MD; Birmingham, AL; Central Connecticut; Jacksonville, FL; New Orleans, LA; Philadelphia, PA; Providence, RI; South Florida; and Washington, DC. Before designing a solution that can be used to address the uprising problem which specific to scaffolding accidents resulted into serious injury or fatality. The research approach was to design a checklist to evaluate supported scaffolding which was labeled as acceptable or unacceptable. Acceptable rating must have no hazards or any sort. The scaffold may have numerous errors but not have any major hazards that might but workers at the risk of fatal fall. Unacceptable rating indicates that the current equipment has serious hazards and/or imminent hazards. Some example of imminent hazards is the following; “are workers on a single plant where a slip could result in a fall, workers on scaffolds without railing or fall arrest systems, and severely overloaded or scaffolds without ties” and “an example of a serious but not imminent hazard, would be missing railings, on the same platform as the workers, but more than 10 feet away from them” (Halperin & McCann, 2004). The following stated above are some of the potential accidents that may occur due to the negligence of practicing proper safety. After using the checklist on the 113 scaffolds, 77 of them received a rating or acceptable and 36 of them received the rating of unacceptable.

According to the article, “scaffold injury incidents occur in two ways- falls from scaffolds or scaffold collapses” (Halperin & McCann, 2004). Scaffolding accidents occur on a yearly basis which result from an individual fall due to a number of risks to pick from and a collapse of equipment which results from failure of material. The scaffolding checklist consists of information based on the following; general background on job, use of scaffold, determine if there is a competent person on the scaffold, scaffold information, platforms, access, PPE, and other important information. In the general section of the checklist, questions are asked about the
GC, number of workers, trades observed, site, city, etc. In the use of scaffold section, information asked is about what trades are using the scaffold, contractor responsible for scaffold, work being performed, items seen on the equipment, and number of workers using the equipment. Competent person section of the checklist indicates if there is an employee who received scaffolding training from OSHA, scaffolding license or certification, years of experience, title of employee, if they are present, and etc. The scaffolding information section indicates the length, weight, height, width, material, and information on how the equipment is set up on the jobsite. Platform section gathers information on the total number of platforms, height, width, length, if they are being used properly, etc. Access section ask questions regarding the type of access points, if they are tied properly, what frames are being used, etc. An important section is PPE, which indicates if workers are wearing the correct PPE for jobsite and scaffolding and if they are being used correctly. Last section is the other which gathers information on hardhat count, eye protection count, general safety of equipment, and rating of equipment which is based on all the information gathered for the survey.

In conclusion, by implementing this particular survey for an all project basis that is utilizing scaffolding equipment has the potential to benefit companies but most importantly ensure the safety of workers. If they use the survey, jobsite will be able to indicate whether the equipment is rated as acceptable or unacceptable. By rating an essential equipment to construction, the industry has the ability to mitigate the risk of potential accidents involving scaffolding. The article states, “with the lack of such injury records, it is still better to implement these scaffolding safety recommendations than not to, because a scaffold that cannot collapse and one that the workers cannot fall off should prevent future injuries” (Halperin & McCann, 2004). Even though specific data related to serious injury or fatality rate are unavailable, its beneficial to implement all scaffolding safety recommendations because at the end of the day everyone wants to go home and see their families. To ensure these particular results, a number of recommendations must be implemented to decrease the risk of a potential accident occurring in the future.

Analysis

There are a number of different prevention programs that are being used to increase scaffolding safety. According to OSHA, Commonly Used Statistics, the construction industry has a term referred to as the “Fatal Four.” The “Fatal Four” are the following; falls, struck by object, electrocutions, and caught in or between equipment which results into a worker fatality (OSHA, United States Department of Labor, 2018). The following stated above are the common cases that cause fatalities in the construction industry. OSHA indicates that by eliminating the “Fatal Four” it would save 631 workers; lives in America every year (OSHA, United States Department of Labor, 2018). After thoroughly review of scholarly articles, the most common prevention program is proper training for employees and advocating the importance of wearing the required PPE. Employees who are able to be properly educated on scaffolding safety, scaffolding information, and overall safety on an individual basis and group basis shows the best results in the construction industry. When wearing the correct PPE for scaffolding, workers ensure their safety when working in the construction zone.
As said before, the prevention programs that are being implemented into scaffolding safety are; proper employee training, implementation of technology to creating BIM objects which can be used for temporary activities on the jobsite, strict compliance policy on regulations and laws for scaffolding, implementing a scaffolding survey to determine if equipment is acceptable to use or unacceptable, must use equipment such as guardrails, handrails, opening protection, and lastly management skills. Prevention programs have the ability to adapt to the industries workforce culture. Simply implementing a program for the workforce will have the potential to increase the safety which has the capability to decrease the risk of future accidents. As said before, there are a number of programs being tested today, but also show some limitations to implementing these programs. Proper training for employee’s limitation would be finding the time to train the workforce and ensuring if the workforce will retain the information. Implementing technology limitations would be an expensive tactic which usually gets the industry tuned off because the goal is to save money but ensure quality. Being compliant with regulations and laws comes from management, if the management shows excellent leadership skills then companies will be complaint but there is also management who don’t show this trait. Lastly, taking a survey to rate the current equipment acceptable or unacceptable would simply take too much time to complete. The current survey is very lengthy and very detailed questions.

Although, these prevention programs each have their limitation when attempting to implement into the industry, the workforce must remember that there is no price on ensuring the safety of everyone. I once heard a Superintendent state “The goal is to get everyone home safely to their families each day” which I agree with completely. When working construction, everyone wants to be as safe as they can be but also work with speed, efficiency, and effectiveness. After in-depth review of programs, the best prevention program is to provide training to the workforce and provide the proper PPE for scaffolding. Simply holding safety training for specific equipment would help educate the workforce on what they will be working with, how to avoid potential risk of accidents, know when equipment is safe and unsafe, etc. Also, in the near future implementing technology as a prevention program will begin to take over the industry but for now the best program will be to educate the industry.

Conclusion

According to OSHA, Fatality Inspection Data, 2017, 20 fatalities were reported which was out of 769 fatalities (OSHA, United States Department of Labor, 2018). 20 fatalities account for 38.45% which is the fatality rate for scaffolding accidents in 2017. In conclusion, this research was to search for current prevention programs that are specific to the current problem of scaffolding accidents. Scaffolding accidents in the construction industry typically lead into serious injury or a fatality of a worker. The construction industry is now attempting to implement more programs that have the potential of decreasing the risk of future accidents on the jobsite. After thorough review of programs, the prevention programs that receives more of a positive response is training which educates the workforce on scaffolding equipment. Many of the
literature review, mentions to require training for the workforce especially when operating or working on dangerous equipment. Required training also should be followed with required protection from falls. From the results of this research paper, it is found that education is the best prevention program because it is widely accepted from the workforce and shown to show positive results.
Works Cited


