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Improving Safety in Residential and Commercial Construction Sites in the U.S

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Abstract:
Background:
There is a high risk of working in the construction industry in the U.S. because it contributes to the majority of the fatalities among all organizations, and the sections of construction with more fatalities rate are the residential and commercial constructions. Therefore it will be necessary to focus on the safety of residential and commercial constructions. Doing so will lower the accident rate for both construction and overall records.
Eighteen previous related research reports were observed and it was found that five of the studies could be used to represent all the eighteen earlier experiments. These were used to carry out further investigations. The results were analyzed which was used to find a safety measure that will be suitable and effective in improving both commercial and residential safety in the U.S.
The findings indicate that 91% of construction industries in the United States practice training and safety meetings and frequent site work inspections. Also, the media contributed towards improving construction safety. Some researchers used 3D immersive visual VR in some construction companies to train employees and it shows an advantage over the traditional method. Other experimenters focused on using Proactive behavior-based safety (PBBS) management to improve construction safety in China. Increasing leader-based site verbal safety communication in two interventions improved safety by 7% and 12%.
In conclusion, three methods were selected which if included as safety measures in both residential and commercial construction sites it will reduce the percentage of both fatalities and non-fatalities records in the construction industry and overall accident records in the United States. The methods are (1) Using Virtual reality instead of the conventional methods for training employees (2) increasing leader-based site verbal safety communication at construction sites (3) applying the Proactive behavior-based safety (PBBS) method.

Keywords: *Safety, Residential and commercial construction, Improving safety, Fatalities, United States, Non-Fatalities*

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I. Introduction

Construction safety is hazardous. While the construction industry and government have tried to make worksites safer, construction remains a risk industry in which to work (Mroszczyk, 2015). Han, Kim, Lee, and Seo (2015) found that even though the construction sector contributed to about 5% of the workforce in the U.S., serious injuries in the construction industries account for about 18% of all occupational deaths. They added that the incident rate for non-fatal occupational injuries and accidents in construction is 30% higher than average industries. These results show an urgent need to reduce the prevalence of fatal and non-fatal injuries in construction (Han, Kim, Lee, & Seo, 2015). Among all of the accidents occurring, the aspects of construction that contribute most to the occupational deaths are commercial and residential constructions, which call for serious attention.

Previous research shows different methods for improving construction safety. Communication is one of the approaches used by some authors. Check and Schneider (2010) carried out research on the role of media in improving construction safety. In their study, they stated the potential of traditional news media to improve construction safety and health, by bringing out important issues through in-depth reporting. They also used the path taking by social media and internet based to go with the traditional media. The authors also presented some examples of some reports from the conventional press on how it has helped create awareness on safety and health and explain how the internet and social media can help in improving safety. Also, they promote personal stories to show the importance and effects of the issue and use non-traditional media effectively as a tool to work with the traditional one to pass the information on safety, health, and injury prevention messages. In

conclusion, the authors stated that the construction safety and health community needs to develop a close relationship with the media, and express the potential for public impact (Check and Schneider, 2010).

In similar research, Andersen, Dyreborg, Kines, Mikkelsen, & Spangenberg (2010) carried out a finding on increasing leader-based site verbal safety communication on safety and safety climate at construction sites. In the experiment, they used well formulated five construction workgroups. The groups are divided into two and foremen in both groups are taught and gave feedbacks twice a day on their daily verbal communications with the workers on safety. The result shows that foremen communicate with the workers multiple times during work hours making the workers view safety as a slice of their verbal communication. This increase the degree of safety in the two intervention groups by approximately 7% and 12%. However, the researchers stated that an increase in safety climate was observed in only one group because they paid more attention to safety.

Some other research was conducted on the change in workers behavior; one such research is on active behavior change safety interventions in the construction industry. The study aimed to review the evidence for the effectiveness of active behavior change safety interventions in the construction industry. The authors' used a systematic approach to finding the intervention characteristics that are mostly related to effectiveness in reducing injury rates. They improved safety behavior using intensity/frequency/duration, behavior change techniques (BCTs) and theory-base (Allom, Mullan, Paterson, Sainsbury & Smith, 2015). The authors also used electronic literature research to experiment, and the interventions used during the study are eighteen years or over. According to them, the methodology quality is poor, and some errors exist in the theory. Finally, the researchers stated that systematic testing of such interventions using RCT designs is necessary to find the most appropriate means for reducing the effects of improper work safety on society at all levels.

Gray, Huang, Hsu, Li, and Lu (2015), focused on Proactive behavior-based safety (PBBS) management for construction safety improvement. They combine the traditional Behavior-Based Safety (BBS) management plus information technology called the Proactive Construction Management System, in which the authors and the virtual prototyping construction laboratory (CVPL) of the Hong Kong Polytechnic University formed. PBBS provides both qualitative and quantitative ways to improve construction safety. The authors also mentioned that similar to BBS, PBBS includes four well-defined steps. The steps are monitoring behaviors based on location, measuring safety performance using the quantitative method, finding out the likely cause of unsafe behaviors, and boosting safety management efficiency. The experiment result indicates an improvement in the two projects teams used during the research by 36.07% and 44.70%. At the end of their discovery, the experimenters concluded that long-term implementation of PBBS management could instill robust safety awareness behavior in workers, who can then produce habitual thinking of safe ways to perform all construction activities. PBBS management also has the potential for global use as does the amended vision of BBS, which is tailored to the construction industry.

Barak, Perlman, & Sacks (2013) tested the explanation of a phenomenon that safety training in virtual reality (VR) in construction sites would be seen and will be more effective in terms of workers' knowing and recalling in identifying and assessing construction safety risks. Therefore, the method would be more preferred than the same type of training using conventional methods. In the research, training for construction safety was provided to sixty- six workers, but their knowledge on safety was tested before the training began. Immediately afterward, half of the subjects were given traditional classroom training with visual aids; others were trained using a 3D immersive VR power-wall and the same process was repeated after a month. The result indicates that VR training for stone cladding and cast-in-situ concrete work has significant advantages, but general site safety has the opposite. VR training was more effective in terms of keeping balance in trainees' attention and concentration. Also, according to the authors training with VR was more effective over time, especially in the context of cast-in-situ concrete works.

Han, Kim, Lee, and Seo (2015) carried out literature research on computer vision-based safety and health monitoring to know the existing state-of-the-art methods and their recent achievement. Secondly, to bring out the major challenges and limitations commonly found in the studies and offer ways of solving problems for future studies. Finally, after the end of the research, it shows that the method could immensely contribute to improving safety in the construction sectors, but further research is needed in these areas.

Some authors (Issit, MA, & Micah (2015), wrote a book on alarm, with a prominent concern in the construction industry. According to them the use of "personal sensors" on some specified workers, which only activates when the worker is at risk of getting close to vehicles or other types of work hazards on site, could help improve safety. They went further to say that the use of computer monitors and personal sensors could also help to reduce the number and frequency of alarms, thereby making the remaining alarm signals more relevant and noticeable.

II. Methods

Only relevant papers related to the current research were used during this review, for instance, a study on improving safety on machines used for highways construction will not be eligible for this review. Out of eighteen papers found, five research studies are more related to the current literature review, which are the

studies that are more correlated to residential and commercial constructions. All the papers were examined to ensure their effectiveness and suitability for improving residential and commercial safety.

2.1 Participants

The majority of the participants are top executives of construction companies, safety managers, foremen, construction workers, and students. For example, Andersenn, Dyreborg, Kines, Mikkelsen, and Zohar (2010) confirmed that 7 foremen participated with 5 construction workgroups. In the research on construction safety training using immersive virtual reality, 71 participants took parts into 4 groups. Members from groups 1 and 3 are site workers from the school of cast-in-situ concrete vocation training course, Group 2 members comprise third -year students of the civil engineering department from a university (Barak, Perlman, and Sacks, 2013). Also, in another study on improving safety through workers attitudes and behaviors, all site workers in a construction site participated (Han, Lee, Moon, Park, and Sheen, 2014).

III. Results And discussion

There are many more related researches conducted on construction safety in which they all focus on the construction sector as a whole, but this research only focuses on residential and commercial constructions because they contributed majorly to all the construction accidents occurring in the U.S. Concentrating on only residential and commercial constructions safety will reduce the percentage of accidents in the construction sector. Also, there will be an enormous reduction in the overall data for fatal and non-fatal injuries in the U.S. The research aimed to collect all of the methods discussed by the previous researchers, and select the methods that will be more suitable and can be used effectively in both residential and commercial constructions to improve safety.

Check and Schneider (2010) used the media in their research, but the method will not be effective because not everyone watches, listen, or trust the media. In the research carried out by Andersen, Dyreborg, Kines, Mikkelsen, & Spangenberg (2010), the method used was accurate according to the authors but the result shows only an increase in the level of safety in both the intervention groups, with an increase in safety climate for just the group that paid more attention to safety. The active behavior change intervention method used by (Allom, Mullan, Paterson, Sainsbury & Smith, 2015) is not dependable because the authors stated that the methodology quality is poor and there are some errors in the theory. The Proactive behavior-based safety (PBBS) will be an effective and reliable method because there was an improvement in safety in the study by 36.07% and 44.70%. Also, the researchers stated that long-term use of Proactive behavior-based safety management would instill strong safety perception behaviors in workers. The workers can then produce habitual safe methods of thinking to perform all construction activities, which will be proactive. The authors also mentioned that PBBS management also has the potential for global use, as does the amended vision of BBS, which is tailored to the construction industry as such the method can be used in every country. Training using virtual reality (VR) is also a technique that will be suitable and effective in residential and commercial buildings because of the heights of the structures. VR training is more effective in keeping balance in trainees' attention and concentration. The technique also has more influence on trainees for high-level buildings than the low-level ones. According to Han, Kim, Lee, and Seo (2015), the research carried out on computer vision-based, safety, and health monitoring needs further research, so is not a method that might be considered using for now. Also, applying alarm to improve safety in construction sites is a good technique for enhancing safety within the construction environment but it will not be that helpful in residential and commercial constructions because it only activates when a worker is at risk of coming closer to vehicles or other kinds of work-related threat or danger.

IV. Conclusion

The research results reveal that most construction organizations practice safety and training meetings and frequent site work inspections. And going by what Han, Kim, Lee, and Seo (2015) discovered, they stated that though the construction sector contributed to approximately 5% of the percentage of workers in the U.S., the fatalities in construction firms have a higher percentage of occupational deaths. This entails that death remains a threat despite applying safety and training and frequent site inspection by most construction companies in the US. While this method is suitable for implementation in the residential and commercial constructions environment, the finding indicates that the methods are not effective enough to bring down the level of residential and commercial construction accidents.

A previous investigation also indicates that most construction organizations do not employ the service of a safety manager, which is the reason behind the increase in fatalities. The suggestion call for further research to examine if it will impact the reduction of accidents, a positive result will be a good choice in residential and commercial sites. Some construction firms planned on implementing the employee involvement and evaluation strategy between the years 2008-2020, it may or may not be a good idea unless an investigation

is carried out to examine its effectiveness. The zero target program practice by a vast majority of organizations in the UK will be a better technique in residential construction since the technique is easy to adopt. Still, the implication is that most firms who practice it have no idea of what it is.

Leader base verbal communication is a method that is suitable in a residential site since foremen are so close to their workers. The closeness will enhance the rate of communication, also the result indicates that the percentage increase in the safety measures as compared to others is high, which shows the effectiveness of the technique. The method is not costly, and the workers will find it very easy to adopt since it only involves communication. The safety rules will easily be remembered since it forms part of their daily discussion, and this will not affect the progress of the job because both the leaders and workers have their various assign jobs.

In conclusion;

1. since all employees receive training of some sorts in both residential and commercial construction companies. Using Virtual Reality in place of the conventional methods will be more beneficial because the technique is more effective in keeping balance in trainees' attentiveness, especially for high-level structures like residential and commercial buildings, which will significantly improve safety.
2. Also, increasing leader-based site verbal safety communication will improve the level of safety. This will happen because the result of the research shows that communication between foremen and the workers multiple times in a day makes the workers see safety as part of their verbal communication. Though, an increase in safety climate might have a slight effect depending on if the workers paid attention to safety or not.
3. The Proactive behavior-based safety (PBBS) method should also be included in the two methods above to make the workers proactive, making all employees pay heed to safety.

Adding the three methods above to other methods used by companies for residential and commercial sites safety will significantly improve safety in construction sites in the U.S.

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