Safety Showdown:
Divergent Approaches to Construction Site Safety in the United States

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Construction is one of the most dangerous industries. According to the National Safety Council (NSC), in the United States the construction industry ranks in the top four employment sectors in death rates and ranks first in the number of deaths yearly (NSC, 2023). From 2017 to 2021, the number of fatal injuries remained relatively unchanged at about 1,040 annual deaths, indicating a stagnation in safety improvements (U.S. BLS, 2021). Injuries cost the industry over $11.5 billion annually, compelling construction companies to seek ways to improve safety (Berglind, 2021; Waehrer et al., 2007). The consistent annual injury and death tolls, however, underscore the industry's sluggish adaptation.

Employers and workers can use some technological innovations to prevent injuries on the job. Okpala, Nnaji, and Karakhan (2020) state that artificial intelligence, Building Information Modeling, and augmented and virtual reality can make construction sites safer. Employers and workers can use some technological innovations to prevent injuries on the job. Okpala, Nnaji, and Karakhan (2020) state that artificial intelligence, Building Information Modeling, and augmented and virtual reality can make construction sites safer. At construction sites, digital safety systems have been replacing or complementing older safety practices.

In the U.S., construction companies, workers, unions, construction equipment companies, and technology companies compete to influence how construction site safety will be improved. Because these groups' goals and resources vary, the safety techniques they promote vary, too. Construction and technology companies tend to favor high-tech safety systems more than workers and their unions, who often attribute companies' safety agendas more to cost savings than to a real commitment to workers' wellbeing.

Literature Review

Researchers have studied construction site safety methods. Abankwa and Rowlinson (2022) contend that construction sites have slowly adopted technological innovations. Even the best workplace safety innovations can offer nothing unless employees and employers adopt them.

According to Henderson and Ruikar (2010), as cited in Abankwa and Rowlinson (2022), slow implementation of safety innovations is evidence of a "behavioral problem." Although initial efficiency rates on-site while using the new technology may be low, these technologies have been found to "enhance productivity, elevate efficiency, protect the environment, and improve safety performance" on the construction site as workers adapt to the new practices (Agyekum, 2021). Proper training and encouragement of new technologies and practices have been found to increase effective implementation as the workers will be more likely to adapt to the change (Henderson & Ruikar, 2010). This research examines how workers respond to the introduction of new technology to their jobs. Further exploration of construction workers' responses to new technologies and other safety changes can provide insights into their role in enhancing safety.

Rodrigues, Baptista, and Pinto (2022) have found that using Building Information Technology (BIM) has improved workplace safety by offering the capability to create a virtual representation of construction sites before a project starts. This preemptive approach enables the identification of hazards up front so that contractors can implement additional safety measures and keep focus on problem areas. According to Rodrigues, Baptista, and Pinto (2022), BIM can pinpoint areas of concern, and "safety documents [can be] integrated into the model simultaneously" to be proactive (Rodrigues, Baptista, & Pinto, 2022). Moreover, by exploring

the technologies and their integration into the industry, it becomes possible to examine the strategies technology companies employ in manufacturing and marketing their innovations. Examining the reception of these technologies in the construction industry can shed light on how different stakeholders are contributing to improving safety.

Researchers have explored the social responsibility of construction companies in enhancing job safety, explicitly finding that from a moral standpoint, construction companies must have safety practices for their workers, known as corporate social responsibility. However, this commitment is not always seen as a legitimate effort by the contractors but sometimes "just a ploy by companies to enhance their reputation and public relations" (Mavroulidis et al., 2022). Contractors often implement additional safety measures to keep their public relations high and retain consistent work. The research above shows that contractors prioritize profit over their employees' social welfare. Further investigation into these moral obligations can provide insight into how construction companies are working towards increased safety in the industry.

Construction companies

Construction companies bear an essential responsibility for ensuring the safety of their employees and have a moral obligation to protect those working in harm's way. Although safety may not always be the foremost priority, profitability frequently emerges as a leading incentive motivating endeavors aimed at enhancing job site safety.

Data from the Occupational Safety and Health Administration (OSHA) illustrates that investing in safety measures can lead to large savings for construction companies. For every $1 invested in safety, companies could save $4 to $6 (OSHA, 2002), a significant benefit particularly crucial for the injury-prone construction sector.

Training workers is a typical way to improve workplace safety. However, not all companies invest the same amount of time or money into safety for their employees. Faulconer Construction in Charlottesville, VA, provides and requires OSHA ten-hour training to all employees but offers and does not require OSHA thirty-hour training and other crucial training, such as first aid and CPR to those who wish to obtain it (Faulconer Construction, 2023). Many companies provide this training to their employees as they begin their jobs. The costs associated with putting all their employees through these training courses is likely a reason for not requiring them for all.

On the contrary, early investment can cut down on costs due to safety-related incidents in the future. Unlike Faulconer Construction's limited safety training, Hourigan Construction in Richmond, VA, requires OSHA thirty-hour training for all operations personnel, which personnel must renew every five years (Dunmire, 2023). This additional training incurs initial costs but yields substantial future savings by preventing accidents. This difference in training shows the disparity in construction safety approaches between companies.

With medical expenses and administrative costs of injuries in 2021 totaling $94.1 billion, contractors want to avoid taking these losses (NSC, 2023). Not only are there direct costs associated with workplace injuries, but there are other costs due to loss of productivity. In 2021, the construction sector lost 70 million employee workdays due to injuries (NSC, 2023). Injuries in construction result in fewer available employees for job sites, reducing productivity, causing delays, and decreasing overall efficiency rates, which in turn impacts the project's budget negatively. These losses' monetary value, including wage and productivity losses, total $47.4 billion (NSC, 2023). Further, any loss of life in the industry costs companies up to $1.34 million lost per employee death. Construction companies may invest in safety upfront because all these

losses and costs due to workplace injury can add up. By investing early, the companies are attempting to reduce financial risk associated with safety in the future.

Financial advice provided to construction companies often emphasizes increased safety by construction companies to increase profit and appear attractive to potential clients in the future. A financial company, Smith Shafer, advises construction companies to implement safety to "enhance its reputation, ultimately leading to increased profitability" (Smith Shafer, 2023). They advise companies this increased reputation will make them more attractive to potential customers. This advice shows a heavy emphasis on profitability and future reputation when it comes to safety rather than focusing directly on the safety of the employees, which should be a "corporate social responsibility" of construction companies (Mavroulidis et al., 2022). Construction companies often prioritize their revenue over safety prevention measures that may incur costs to the company, considering revenue as of utmost importance to themselves.

Workers & Unions

Workers and unions in the construction industry are at the forefront of advocating for safety measures, driven by their desire for increased safety and protection for themselves. Technology implementation often serves as a solution for improving safety. However, workers and unions may occasionally skeptically view the adoption of newer technologies and the pursuit of heightened efficiency, especially when these initiatives present themselves as efforts to enhance safety.

According to Informa Markets (2023), 40% of construction workers sometimes feel unsafe. If workers feel unsafe at work, additional unseen hazards could also pose a danger. Given

the many other hidden dangers in their field of work, workers who feel unsafe at work are likely to be open to new safety improvements.

In places where workers are unionized, there is more pull on the companies by the unions to increase safety. Fox (2024) has found that the "unionized workforce [has a greater] ability to speak up for safety" because of the pulls that unions have on their employers. This influence stems from the fact that without the labor from the unionized workers, the construction companies would have to resort to other means of a labor force, such as non-unionized workers, temporary workers, or even subcontracting their work out. Subcontracting work out is a worst-case scenario that would lead to high costs for the company.

Manzo IV has found that every "1 percent increase in unionization is linked with a 3 percent decrease in occupational fatalities" (Manzo IV, 2021). With this said, unionized workforces may have slightly higher safety numbers than non-unionized workforces. However, their continued desire for safety continues as Boom & Bucket (2023) states that unions advocate “for adequate safety measures [to] protect workers from accidents, injuries, and even fatalities.” As the unions have more leverage with their employers, this creates a cycle between practices being put in place by the construction companies and union responses, known as collective bargaining. Since employee contracts are with union members, the union representatives negotiate directly with the employers for the entire union. Collective bargaining has led to "safer work environments [and] proper safety equipment" in many industries (Boom & Bucket, 2023). If unions grow skeptical of construction companies prioritizing safety over revenue, they hold great power and can negotiate for their members.

Sometimes, as new safety measures are implemented, workers may hesitate to adapt to these changes from their traditional methods. However, these new measures are also likely to

"enhance productivity, elevate efficiency, protect the environment," and improve safety measures by their implementation (Agyekum, 2021). These implementations in the industry may improve worker safety, but workers may see other reasons for implementing the new technology or practice other than improving their safety. After implementation, there is likely to be heavy training and a push for efficacy rates to be high which may turn employees' heads. They may see that the companies are pushing for usage to improve productivity, thus increasing profit.

This push for productivity and profit may directly lead to workers' hesitancy in adapting to the new practices, as they see safety as not the primary reason for implementation. In the case of unions, they may be less likely to increase training on a new practice or even strike if they see construction companies implementing the practice to increase productivity and profit.

Construction equipment companies

While construction equipment companies are not directly responsible for on-site safety, workers in the construction industry regularly use the equipment they market and sell. The safety of their equipment has a direct impact on the end user's safety. Many manufacturers are working to implement new technological innovations into their equipment. An example is Volvo Construction Equipment, which has been installing new remote operation technology into its excavators. Volvo has been trying to sell this newly integrated technology by marketing increased safety and efficiency. Volvo says their new advances have increased safety by allowing construction workers to "operate their excavator in areas where there is a risk of falling objects or where the machine may roll over" without putting workers in further danger (Alström, 2023). Without having an operator in the cab of the machinery during a dangerous operation, the risk to the operator is reduced, thus increasing their safety.

Caterpillar (CAT) has also begun implementing technologies into their equipment. CAT says that safety is a priority and that they have "developed several solutions to help both construction workers and site managers enhance safety on their job sites" (Cashman Equipment, 2022). One solution CAT has developed is installing remote-controlled technology into their excavators, which is directly equivalent to the technology Volvo has also implemented in their machinery (CAT, 2024). Before the implementation of this new technology, equipment costs ranged from hundreds of thousands to millions of dollars within the industry. As equipment companies add digital technology to more and more equipment, the prices will surely increase.

However, the primary motivation behind the dedication to increased safety shown by construction equipment companies is essential to investigate. Volvo and CAT are direct competitors in a diverse market with many other manufacturers. The construction equipment industry is estimated to be worth $123 million (Industry Outlook 2023 Reports, 2024). Volvo and CAT are two of the five largest construction equipment companies, making up 45% of the market. The economics behind these companies play a direct role in introducing technology to improve safety. When one company begins to implement safety upgrades that will increase sales, the other market players are sure to follow course.

Engaged in a competitive race within the manufacturing industry, this is likely the primary driving force behind the heightened implementation of safety systems in their equipment. With a demand for enhanced safety and new technologies in the market, equipment companies are inclined to make these manufacturing advancements for the betterment of their businesses. Companies are not primarily inclined to implement safety measures in their equipment for the end user, but they are beneficiaries of the increased sales produced by these increased safety measures as the result of technology integration.

Technology companies

Technology companies also impact safety in the construction industry as they innovate. Under the cover of dedication to increased job site performance and safety, these companies are often making large profits. Such profits likely significantly influence marketing their technologies to an industry needing safety enhancements.

One of the largest upcoming technologies in the construction industry is Building Information Modeling (BIM). BIM allows construction sites to be virtually modeled before any ground is broken on a project, leading to time, cost, and even safety savings on project sites. A typical construction model has three dimensions: height, width, and depth. BIM modeling can now be done in four dimensions, including time, which allows construction support personnel to create simulations of the buildout of a new building or other structure. Researchers have found that "safety measures to be implemented have been incorporated" in the fourth dimension of the BIM model (Rodrigues, Baptista, & Pinto, 2022). By modeling the project's progression, safety measures in different phases can be predetermined and implemented before the project starts. One of the most extensive BIM software programs that allows for this type of modeling is Navisworks.

In 2007, engineering software giant Autodesk acquired Navisworks for $26 million (Cole, 2007). Autodesk also acquired a company in 2021 called ProEst (Autodesk PR, 2021). This software allows all construction documents, including safety documents, to be stored in one spot. In 2023, Autodesk had a revenue of over $5 billion (Autodesk, 2023). As Autodesk continues to create new software and acquire others, its revenue will only continue to grow. Autodesk may claim this software can improve job site safety, but this is not the primary objective. The consistent revenue stream for Autodesk is likely the main reason for buying and integrating this

software under their umbrella company. Promoting the safety capabilities of software not initially designed for such purposes, while profitable, further suggests that safety is not the foremost motivation behind these technologies.

However, there are cases where technology companies intentionally seek safety advances. An example is wearables in construction, such as the Smart Helmet. The Smart Helmet "measures workers' fatigue levels" to alert them if they begin to doze off on the job (Conexpo, 2021). This technology was unlikely to have been created without the idea of safety in the creators' minds. As opposed to BIM software adapted to increase safety on the job site, the only significant uses of wearable technologies are for safety and efficiency increases. Construction companies can implement wearables for employees to increase job efficiency, but that was not necessarily the creator's intention. However, as with anything sold, technology companies will still profit from the innovation they have created. Technology companies likely have different priorities based on the product they are marketing. Any new technology in the construction industry will likely increase safety, although it may not always be the creator's priority.

Conclusion

Diverse stakeholders influence the construction industry’s safety landscape, each with their motivations and approaches to enhancing its safety. Construction companies, their workers and unions, construction equipment companies, and technology companies all have different reasons and methods for safety, but all push for increased safety. For construction workers and unions, their safety and that of their fellow employees is paramount. Construction safety is primarily seen as a business to most groups outside of workers and unions representing them.

Further, safety is not typically the primary reason for the change, but profit and business, in general, are the leading reasons for their work in construction safety.

Construction companies will likely want to increase safety to remain profitable, as increased safety cuts down on monetary losses due to workplace injuries and time losses. Construction equipment and technology companies are working in construction safety mainly to make profits in a booming market due to the need for better safety measures. Their work is more of a business decision, but all the while, these companies contribute to increased safety within the construction industry. While profitability and business considerations often drive decisions, the outcome remains the same: the creation of safer work environments for construction workers.

As construction will always be a hazardous industry, safety is essential and can continuously be improved. As the industry continues to evolve with the introduction of new technologies and safety practices, ongoing research and data collection will be essential to ensure continual improvement in construction site safety. It is crucial to note the future safety levels in the construction industry. As new technologies and other safety practices are implemented, workplace injuries should decrease in the industry. By keeping track of future injury rates in the construction industry, the confirmation that safety improvements continue even through diverse motivations by stakeholders can be made.

Research should be conducted into the efficacy of new technologies and practices within the industry and their effectiveness in terms of safety. Researchers should also determine other ways to increase safety and their associated costs. This research can provide meaningful data on what practices best increase safety within the industry.

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