Undergraduate Thesis Prospectus

Site Design for a Hotel on Pantops, Albemarle County, Virginia

(technical research project in Civil Engineering)

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

(sociotechnical research project)

by

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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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General Research Problem

How may injury risk at construction sites best be reduced?

The construction industry is inherently dangerous due to the numerous hazards present on any given site. Many injuries and fatalities occur in the construction industry. 1,015 workers were fatally injured on construction sites in 2021, which was unchanged from the four years prior (US BLS, 2021). According to Go Contractor, injuries in construction cost the industry over $11.5 billion annually (Go Contractor, 2021). In addition to lives being saved from increased safety, construction companies could also save money. Construction sites are dynamic and vary by site, so contractors cannot consistently eliminate injury risks. Innovative solutions should be researched and implemented to reduce risks and foster safer environments for construction workers. By reducing risks of injury on construction sites, lives can be saved, and associated costs decreased, all while increasing the efficiency and overall competitiveness amongst companies within the construction industry.

Site Design for a Hotel on Pantops, Albemarle County, Virginia

Within specified parameters, how may developers of a new hotel at Pantops in Albemarle County, Virginia, optimize parcel use and hotel functionality?

The technical research project is a capstone project in the civil & environmental engineering department led by faculty advisor Arsalan Heydarian and professional advisors from Timmons Group. The project team is comprised of student collaborators of myself, Charlotte Gillum, Caroline Lystash, Garrett Warren, and Henry Voter.

The project involves developing a parcel of land in Pantops in Albemarle County, Virginia. The developer requests that the lot be developed such that a hotel with a footprint of

14,000 square feet, a drop-off loop, adequate parking, and proper stormwater management are on the site. The project has several essential constraints, including complying with state of Virginia DEQ requirements regarding stormwater runoff, developing final grading plans, following Albemarle County code, designing utilities around existing utilities in the area, and designing roadway access to the site. The new development must meet all codes from Albemarle County, the Virginia Department of Transportation, and the state of Virginia code. The project's goal is to meet these constraints, while optimizing the use of the parcel and functionality of the hotel.

The team will develop the project utilizing Autodesk Civil 3D software. This software is the standard for design within the civil engineering industry. The team will use further software for modeling stormwater runoff and treatment options for the post-development state to meet all requirements. We will use these programs to lay out different possible options for the development and move forward with a particular design. When a specific layout is chosen, all efforts will focus on this design, and it will be modeled to ensure that the design meets all requirements and criteria. Using these state-of-the-art software packages will lead to a set of completed construction documents at the end of the capstone project that show all aspects of the site's design and can be utilized by construction contractors to develop the site.

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

In the US, how are construction companies, workers, unions, construction equipment companies, and tech companies competing to determine how workplace safety at construction sites will be improved?

The construction industry is one of the most dangerous fields due to the hazardous conditions of every site. According to the National Safety Council (NSC), the construction

industry ranks in the top four industries with the highest death rates and ranks first in the number of deaths yearly (NSC, 2023). Many groups have been working to reduce the risk of injury to workers in the industry due to the high number of injuries. The push for improving safety has come from groups with different interests and approaches toward the single solution of reducing injury and deaths in the construction industry.

There is published research regarding new technologies being implemented to reduce injuries in the construction industry. New technology and its efficiencies in the industry are investigated in one publishing. It has been found that there have been past interventions in the construction industry to try and lower injuries and deaths sustained by construction workers. According to Agyekum, implementing "modern technology or automation" has begun in the construction industry but, unlike most other industries, has not seen a significant productivity improvement yet (Agyekum, 2021). The industry has been falling behind and continued in its conventional ways rather than innovating over time. As new technologies are beginning to be brought into the construction field, employees need to be willing to adapt.

In many cases, employees have been hesitant to adapt to the new technologies, making them less efficient than they should be. This hesitancy is seen merely as a "behavioral problem" rather than an issue with the technologies (Agyekum, 2021). Although the efficiency of the new technologies may start out low, as employees adapt to the changes in their workplace, the new technologies are found to "enhance productivity, elevate efficiency, protect the environment, and improve safety performance" (Agyekum, 2021). The research finds that technologies help with construction safety but bring about an issue of inefficiencies due to workers' unwillingness to change. However, this hesitation by the industry workers can be changed through increased training by demonstrating the usefulness of the new technology.

Another related published research topic is the use of Building Information Modeling (BIM) technology to improve safety on jobsites. BIM modeling can be used before the construction begins, allowing the site to be modeled. This model can allow for safety concerns to be identified before the project. Once identified, additional focus can be put on these areas of concern once the project begins. According to Rodrigues, BIM can be used to locate areas of concern, and "safety documents [can be] integrated into the model simultaneously" to be proactive (Rodrigues, 2022). This technology alone has been deeply researched to determine its effects on construction safety.

Another example of published research on this topic is focused on contractors' evaluation of social responsibility to increase safety. From a moral standpoint, construction companies have an obligation to have safety practices in place for their workers. This phenomenon is known as corporate social responsibility. Unfortunately, corporate social responsibility is not always seen as a legitimate effort by the contractors but rather "just a ploy by companies to enhance their reputation and public relations" (Mavroulidis et al., 2022). It has been found that contractors are less worried about promoting the social welfare of their employees and more about maximizing profit.

There are many participant groups involved in the subject of construction safety. One participant on the topic includes technology companies innovating to increase safety in the industry. Companies are working to "push the boundaries of construction equipment autonomy or enlarge the addressable market for equipment automation" (Rathmann, 2022). This group is working on making technologies more readily available to those in the construction industry. These innovations may increase safety in the field from the implementation; however, these groups are possibly innovating for their monetary benefit.

Another participant is construction equipment manufacturers. These 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 and putting it into their excavators. This implementation has 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" (Alström, 2023). Volvo has been trying to sell this new integrated technology in their equipment to construction companies while stressing increased safety and efficiency. The equipment companies value safety but may also be inclined by increased profit from new technology sales.

Another participant is construction companies. Construction companies are directly involved in construction safety because they oversee the site and employ those who may get injured. While construction companies typically like to finish projects efficiently and make the most profit possible, they have moral obligations to safety on their sites. They may also promote increased safety on site to save money since injuries cost contractors over $11.5 billion annually (Go Contractor, 2021). Construction companies have more than one reason to increase their safety record, but it is important to determine the main reason for their intentions.

Another participant is the construction workers, who are the main ones subjected to the high risks and injuries in the industry. The workers are also the subject of new technologies being implemented and increasing safety in the field. As new technologies are explored and implemented, they are in some cases "removing operators from the most hazardous aspects," thus increasing safety (Strain, 2023). The construction workers are likely open to increased safety but less likely to want to adapt to changes.

Another participant is construction labor unions. The labor union represents the workers of the industry and advocates for the best conditions for their employees. The labor unions will likely be for new technologies that will improve safety. The unions have also led to more organized safety and training for their personnel rather than from non-unionized construction workers themselves. It has been proven that every "1 percent increase in unionization is linked with a 3 percent decrease in occupational fatalities" (Manzo IV, 2021). This increase in safety associated with unionization shows that unions in the industry may have a more significant push for their workers to have better safety conditions than direct employers.

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