Technological Integration to Enhance Jobsite Safety

Luke Barragan
California Polytechnic State University
San Luis Obispo, California

The content derived in this paper portrays the effect that technology has on safety and how it may be enhanced and altered in the built environment. Ensuring safety on the jobsite is the most important aspect of concluding a successful project. Alongside safety on the jobsite is technology, both of which work coherently together to ensure proper construction. Technology has advanced tremendously in the built environment and it is difficult for all aspects of the project to be up to date universally. Safety lacks the technological integration that is found in the design and preconstruction phases of a project. There are software's such as Procore that enable a company to hold all safety construction documents together like JHA's and TBT's, however the efficiency of the safety components within these software's can be improved upon. With new technology being implemented into the world today, I have explored new possibilities such as developing a safety software and implementing robotics, BIM coordination, and wearable technology that can adhere to all safety requirements on a jobsite while also preventing injury. Safety is the most important part of a job and should be held at the highest standard with the help of technology.

Key Words: Technology, Built Environment, Software, Safety, Highest Standard

Introduction

The built environment has experienced tremendous growth over the past fifty years, adhering to the universal innovations that our society has undertaken. Many technological advancements such as building information modeling (BIM) and clash detection have made construction much more efficient prior to breaking ground and during. Although the technological advancements mostly adhere to the design, preconstruction, and construction phases of a project, there have been minimal efforts to further advance safety on the jobsite. Being the most important factor of all projects, safety needs to have the same technological integration to ensure that workers are returning to their family and friends the same way they showed up to work that day. It may seem there are limitations when it comes to changing safety on the jobsite, however, there is always room for improvement. Safety is often looked at as being solely dependent on the actions of those that are in the field doing the work, however, there are so many different aspects that go into it including proper equipment checks, workwear, stretch and flex, etc. all of which have documentation alongside it. There are several different ways of managing safety and every general and sub-contractor has their own way of

managing it. The efforts of safety software's such as Procore allow for documents to be uploaded to ensure the organization of jobsite safety, however once these documents are uploaded, they are rarely referred to unless there is an accident on the jobsite. The main goal of implementing safety standards on the jobsite is to ensure that there are no accidents, not just taking action when there is one. Although safety is heavily gauged on the performance of workers, there is technology that can be utilized in order to enhance safety on the jobsite.

It can be difficult to maintain proper safety techniques and management on the jobsite as there can be hundreds of people working on the job at once. Many times there will be a safety manager onsite to help ensure that workers are being safe while tending to their work. Although this works, there is no guarantee that the safety manager can see everyone at once and keep people responsible for their actions. Due to this, technology can play a huge role in helping maintain the safest jobsite possible. The implementation/development of digitalized documentation and trainings can allow for a smoother and more detailed training process, allowing for all workers to be completely up to date with safety regulations and modern safety practices. The use of high technology equipment such as drones and sensor suits can also adhere to a safer jobsite as they can prevent accidents by giving detailed procedures and assisting with onsite operations such as heavy lifting. Although some contractors cannot afford the highest technology, there are many ways to implement technology such as digitalizing documents and having detailed training videos. Even these initial steps can be taken by all contractors and should be prioritized to ensure that all workers are being safe on the jobsite. Even though jobsite safety is heavily dependent on the physical actions of those working on site, their decisions on site can be altered with the help of technology to ensure that the jobsite is as safe as possible.

Background

The built environment has evolved tremendously going from no personal protection equipment (PPE) to now wearing full body PPE and even having BIM to view projects in 3D and see clash detections and processes to prevent future mishaps on the jobsite. Whenever there is construction happening, there is the possibility of workers being injured, so having minimal construction to do allows for less of a chance of accidents on the jobsite. The possibility of accidents is inevitable and altering the way in which safety is communicated and acted upon is essential to the success of a project.

The passion and curiosities directly correlated to safety are derived from my experience over the course of my construction career. I was introduced to the built environment at a young age, setting formwork and pouring concrete for residential construction to building custom cabinets for a private maker to working for an electrical subcontractor for large underground jobs to project engineering for a commercial general contractor. I have been directly involved with several different types of safety procedures and have seen how each one works relative to the type of work. I have held safety roles for each company I have worked for and have seen the different safety operations run for each company. After seeing the difference in efficiency within safety technologies, I have grown fond of learning more about it and trying to implement new safety strategies so that everyone would be safer on the jobsite. I am passionate about safety and want to explore more ways that innovative technologies can play a role in making safety inevitable on the jobsite. I took a Construction Technology course and learned a lot about how technology is always being improved upon and how it can be used in many ways, including creating a safer work environment. There are many different ways technology is being used in the built environment and I explored all of the possibilities so that I can be an asset for any contractor and the built environment.

Literature Review

Construction safety is often referred to as the most important part of a project, considering that it is the well being of the people that contribute to the success of a project. Although physical safety is only relevant in the field, there are many other aspects of the construction process that contribute to the overall safety of the workers including the utilization of BIM technology and clash detection. Safety is never at a stand still and is always in need of improvement on and off the jobsite. The implementation of technology has been vital in the adaptation of safety in regard to the highly advanced projects that occur in all types of construction. Every aspect of a construction project has safety implementations that are directly correlated to it. Thus being said, the demand for technology to help adhere to safety regulations is imperative. As seen in figure 1 below, there are five main technological innovations that have helped safety on the construction site:

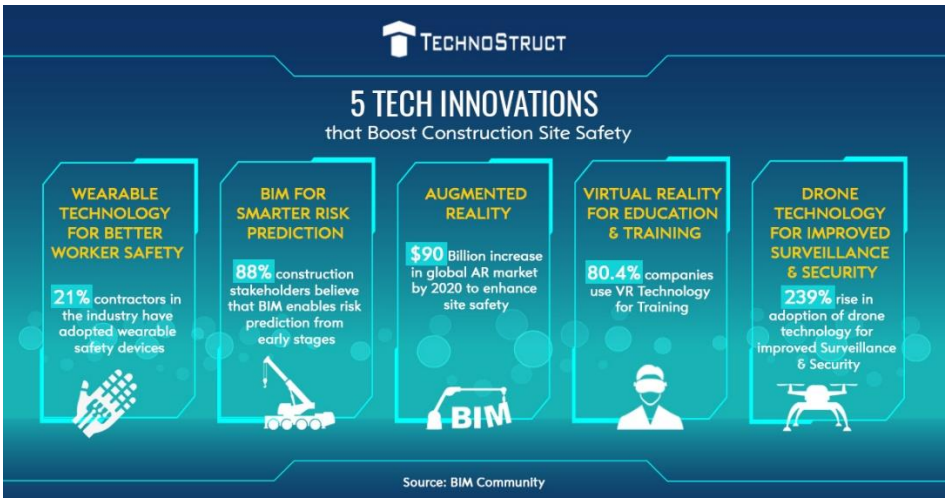

Figure 1: 5 Tech Innovations that Boost Construction Site Safety (TechnoStruct)

Robotics

There are many technological safety initiatives that can take place to ensure safety, however one of the "most exciting and promising for safety outcomes, perhaps, are innovative uses of artificial intelligence (AI) with robotic equipment to safely execute repetitive and dangerous tasks on construction sites" (Mueller, 2022). The utilization of robotics on the jobsite such as drones, allows for difficult construction operations to be ran without the expense of human interaction. The use of robotics allow for aerials and better understanding of specific areas along the jobsite that lead to safer and more confident work process to be held onsite. As seen personally onsite, the use of drones were able to see parts of the project that cannot be seen by the human eye unless a worker went into a dangerous position. Safety is not only being safe in operations but also preventing accidents on the jobsite and technology needs to be utilized in order to ensure that jobsites are as safe as possible.

BIM Technology

Alongside the drastic increase in the use of robotics comes BIM coordination and the effects that it brings to a jobsite. With it being directly tied to software technology, BIM allows for a safer jobsite by illuminating certain areas of a project where there might be clash detection or risk. By having these

things pointed out, there are many processes on the jobsite that can be prevented since the job may not need it at all. With less processes happening onsite comes less opportunity for injury and accidents. In a report written and published by Associated Builders and Contractors (ABC), they explain that "In the construction industry, safety should be the number one priority on every jobsite and, with the increased use of new technology such as BIM, the industry is finding ways to not only reduce onsite injuries, but to reduce the overall construction schedule at the same time" (ABC, 2015). BIM technology can be a broad term that means a lot, however, the ultimate goal of BIM is to enhance the workflow processes and create a more efficient built environment. BIM provides workers with a better understanding and visual representation of their surrounding work environment, resulting in smoother processes onsite. It also allows for work hazards to be detected so people do not have to risk their health in order to perform the operation onsite. BIM also allows for days and activities to be cut off the schedule since it is able to map out a clear process flowchart for the entire duration of the project, all of which adhere to safety since there is a lower level of risk on the project. BIM has shown exponential strides in the technological integration of safety in the built environment and has proven itself worthy that all contractors should adhere to technological advancements.

Figure 2: Wearable Technology: Smart Garmet

Wearable Technology

A unique way that technology has been implemented into the built environment is with the use of wearable technology. Although it is not very common and very expensive, wearable technology is where the future is heading in terms of safety on the jobsite. With the use of various sensors and GPS systems, there are different visuals that can be seen on the jobsite while in the act of performing processes. There is no way for robotics to take over all processes on the job, therefore, humans still need to perform dangerous acts onsite. With wearable technology, workers are able to be safer in the present act and prevent serious injury from occurring. Workers have been using wearable technology for years such as hard hats and vests, however, there are innovative wearables such as "smartwatches, smart helmets, bionic suits, smart glasses, and sensors… allowing users to communicate better and enhance data collection and safety" (Menon, 2022). Wearable technology will be the new standard in the next decade as long as contractors adhere to technological change throughout society. Wearable technology is a great way for workers to be safe on the jobsite and should be worn at all times for those that have that capability. Although some parts of wearable technology is expensive, the benefit

that is gained by utilizing it is well worth the cost of purchasing it and should be practiced by all contractors.

Methodology

The information and perspective contributing to this paper is derived from personal work experience while utilizing several different technologies, interviews with three commercial construction professionals, as well as published papers and articles. The research in this paper draws conclusions that adhere to the imperative utilization of technology to enhance safety in the built environment. By exploring different ways of researching, there is a much more specific outlook on the topic that allows for people to form their own opinions about safety technology in construction. Safety is the most important aspect of the built environment and should be held at the highest standard, therefore, every contractor should utilize the latest technologies to ensure that their jobsite is as safe as possible.

Interviews

Direct dialogue is one of the greatest ways to pass along information while also presenting innovative ideas that should take place in the future. Directly correlated with safety and technology, there were three interviews that took place. One with Javier Garcia, a safety director with Dome Construction and another with Fred Mendoza, a safety manager with Dome Construction. The interviews stood the purpose of gathering information on how safety has changed over time and the state it is currently in. During these interviews, there were plenty of opportunities to present new ideas to help ensure that safety is at the highest priority and is being executed successfully. All three of the interviewees have more than fifteen years of experience in residential and commercial construction while also holding different titles and experiencing different companies. With their diverse background, they were able to provide great personal insight on safety in the built environment and introduce new ideas that should be integrated into the built environment today and in the future. The questions asked pertained to safety, safety technology, innovation, and the built environment to ensure that the information being provided was accurate and informative and all questions were asked to everyone.

Javier Garcia

Having the most experience with safety in the built environment, Javier Garcia was an easy pick to begin my interview process. Having been a safety director in commercial construction for many years, he has the knowledge, experience, and expertise that was needed in order to have valuable input on technology and safety. The first question asked was: “can you see overall safety in the built environment adapt to the latest technologies to benefit safety and ultimately create a safer work environment?” Javier had an interesting take on the questions given that he has experienced several different waves of safety going from no safety vests to wearable technology. He explains that “there are always ways to improve safety and efforts should never be let up, however, being able to introduce new safety efforts that are viable for all contractors to get their hands on, could be difficult.” Given that he has experienced real life safety initiatives make their way into the built environment, Javier knows that innovative safety ideas are expensive and hard to attain. Although safety initiatives can be difficult for contractors to attain including tech glasses and body suits, attending to safety demands is critical and should be held at the highest standard. Developing a software that adheres to all safety requirements including documentation can make it much easier to attain a safer workforce as well. Having all documents and training videos easily accessible allows for general contractors to present safety initiatives from the start and also withhold standards. This led to the next question which was: “what do you think the built environment is lacking in terms of safety and how would you

go about changing it?" In his firm standing, Javier responded saying that the "lack of dedication from onsite laborers and representation from OSHA, is setting up the workforce for failure in terms of keeping our workers safe and there should be a higher demand for safe work processes." He then went on to say that "in order to change it, safety initiatives should be a lot easier, like having more user-friendly software and field technology so that all workers can be safer easier." He made a great point in that workers do not have the buy-in for safety, especially due to that many workers started when safety was not as prioritized as it is now. It is common for workers to continue to do work the way they seem comfortable instead of adhering to safety protocols such as wearing gloves and safety glasses. With the help of safety technology, these efforts will be much easier for those that are anal about working the old fashion way. With technology, the processes will be easier and safer as there will be less risk of injury due to precise operations and detection throughout a project. Developing a safety software that is easy to understand and can be presented in multiple languages will allow for all workers to be able to see safety documents and processes to ensure that they are being safe on the jobsite. The conversation then led to the final question which was: "how can technology benefit safety and what is the goal for the future?" Javier went on to say that "technology will allow the built environment to advance to new heights that have never been reached before. The technology that is implemented in all aspects of a project, not only safety, will help create a safer environment because there will be less operations ran which means less room for injury." By introducing technology such as wearable aspects and BIM coordination, every contractor, large and small, will benefit due to the lack of injury. Although mitigation one hundred percent of injury is merely impossible, minimizing it is the ultimate goal and can be done so by utilizing new technology into the built environment. Javier's expertise provided a great bank of knowledge for where the built environment needs to be in the future and how technology can be a great asset for the improving safety.

Fred Mendoza

Being a safety manager, Fred Mendoza was a great interviewee and was able to provide more information about onsite safety and what he experiences on a day-to-day basis. Always being onsite and monitoring the workers on large commercial construction jobs, Fred has seen a diverse range of operations being ran by workers of all trades. He manages all safety aspects of the job including trainings and orientations for all workers. Fred relayed to me that "most of the injuries he sees are from people utilizing their safety equipment wrong and by working into hazards that should have been avoided if the correct safety initiatives were taken in the first place." He also went on to say that the contractors that use "advanced technology such as clash detection and tech glasses are much safer on the jobsite and less prone to injury." Given Fred's account on safety operations within the field, it is easy to see that with advanced technological initiatives, workers have a more efficient workflow process on the job with less room for error. Working for Dome Construction, they use a safety software called eMOD that organizes all documents and workers into a system that is easy to access and navigate through. With eMOD, all workers can check any safety documents they need to ensure that they are performing operations safely and according to the laws and regulations of OSHA. The conversation then led to speaking about workers freedom onsite and how it is impossible to watch everyone all the time. Thus being said, with safety technology, it is easier to keep track of all workers on the jobsite due to being able to see anywhere onsite at all times using drones and cameras. Furthermore, with safety technology, workers can perform their operations more easily and comfortable, allowing them to adhere to safety regulations while not being watched. This is done by having the most minimal work possible and completing the work that does need to be done, in a safe manner. Fred proclaimed that the "ultimate goal is for workers to go home the way they showed up to work that day, to make sure they are injury free and can spend time with their family and friends without work being in the way." Safety is often undermined and forgotten about when operations are

being ran onsite, however, it is the most important part of the job. Utilizing safety technology will allow for not only workers to be happy, but also family, friends, and loved ones, post work. These reasons alone are why safety should be so emphasized in the built environment and will remain the most important aspect of every job. Fred went on to say that “safety has come a long way the past decade and I am excited to see what it will bring us in the next one.” There are always ways to improve and with all the new technology that is being brought up in our world, there needs to be an emphasis on using it in safety as well as the operational side of a project, as the two work coherently. The knowledge Fred provided in the interview gave great insight on how safety should be looked at versus how it actually is. Safety should be held at the highest standard and companies need to utilize technology to advance safety efforts on the jobsite to ensure that everyone is returning to work the way that they showed up.

Conclusion and Future Research

Being the most important aspect of every construction project, safety demands the most attention and resources in order for the project to be successfully completed. By implementing new technology efforts such as BIM coordination, robotics, safety software, and wearable technology, safety will take a turn for the better. The use of BIM coordination allows for clash detection to ensure that there are minimal operations being ran all together, resulting in less of opportunity for injury. Robotics allow for there to be eyes on all parts of the project and even replace human interaction in various aspects of the job. Safety software adheres to the collection of all data and documents on the jobsite so that every project can be clearly defined and responsible when performing operations. It also allows for workers to have direct ties with their own safety by enabling them to physically see how they are supposed to perform their operations from a safety standpoint. Although it is newer to the built environment, wearable technology such as tech glasses and body suits prevent injury as they can catch clash operations and in-the-moment processes while work is being performed. Although these efforts may seem expensive, contractors need to allocate funds towards safety and ensure that their workers are performing all operations according to laws and regulations. Technology is drastically changing the way the built environment is ran and developing software and using these efforts is the best way to create a safer workplace.

Considering technology is continuing to change every day, the safety efforts linked with technology will also continue to change over time. The initiatives that will be taken in ten years from now will be drastically different as there will be many more robots performing the work of humans to eliminate operations all together. The research will never end and there will always be room for improvement. Although the execution of human involvement in the built environment will delete jobs, creating a safer way to perform work is essential.

References

Bell Integration. (2021, October 14). *IOT smart garments and wearable technology for industrial use*. Bell Integration. Retrieved November 29, 2022, from https://www.bell-integration.com/capabilities/transform/iot-solutions/smart-garments/

Ellis, G. (2022, November 3). *100+ construction industry statistics*. Digital Builder. Retrieved November 29, 2022, from https://constructionblog.autodesk.com/construction-industry-statistics/

Newsline. How BIM Can Create a Safer Jobsite | Newsline. (n.d.). Retrieved November 29, 2022, from https://www.abc.org/News-Media/Newsline/entryid/3791/how-bim-can-create-a-safer-jobsite-

You are being redirected... (n.d.). Retrieved November 29, 2022, from https://visilean.com/innovations-in-wearable-construction-technology/