Using software to shape safety on the construction site

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Abstract. This article discusses the use of construction site safety shaping software to prevent the various hazards that can haunt workers at a construction site. For this purpose, various methods will be considered, among them: PLANRADAR software, which is able to ensure monitoring of all stages of work and prevent many errors; BIM technology, able to show a full-scale model of the project both as a whole and in sections; intelligent camera systems, able to perform analytics and analysis with the help of specialized artificial intelligence and machine learning. As shown, such technologies can increase the level of compliance and safety control at a construction site through constant monitoring of both workers and construction sites. Safety violations are minimized and traumatic situations are prevented before they occur.

1 Introduction

Safety is the basic foundation of any construction job. Being a construction worker is already a dangerous job, but on top of everything else there are many factors that make safety on a construction site even more questionable. Things like faulty equipment or a simple disregard for safety can make the situation even worse.

Many injuries can occur to a worker during the course of a work plan, among them:

- Contusions;
- Burns;
- Cuts;
- Fractures;
- Electrocution.

Such things as good equipment, which can reduce the damage a worker suffers even if he is capable of neglecting safety, can certainly save him from such dangers. But with the advent of modern technology, such a problem is becoming less and less acute.

Undoubtedly, following safety standards and using the proper equipment can avoid traumatic situations for even the most inattentive construction worker who purposefully neglects his own protection in an effort to perform his job duties as quickly as possible.
However, advanced technology has made it possible to account for and prevent, or at least reduce, workplace accidents.

Most employers argue that it is possible to get the job done without the latest technology, as advanced techniques make it possible to stay on schedule and complete tasks efficiently. Also, one of the challenges is the desire to save as many resources as possible, including not investing in special safety equipment, but resorting to available tools and materials [1-10].

Safety of construction projects is taken to a new level by modern technology, which is improving day by day for the proper quality and automation of various work. Nowadays construction workers can afford to wear exoskeletons, with which they can easily increase their stamina and reduce the level of injury. Today's robots can do dangerous and grueling work, and most importantly for construction companies, much faster than a human worker. All-seeing drones, which ensure safety at the construction site by means of automatic hazard recognition technology and rudimentary cameras. And finally, conventional software that transmits all the information in real time and has its own unified system.

2 Safety management software for construction sites

On a construction site, health and safety workers were constantly faced with the need to fill out many different documents and templates. Their main responsibility was to ensure safety on the site. This included enforcing safety standards and regulations, overseeing the implementation of safety measures, providing protective equipment for workers, conducting mandatory briefings, preventing injuries, and filing reports—all of these tasks were performed by an occupational safety inspector.

Most of the time the occupational safety officers had to spend on arriving at the production site and filling out various documents, inspection reports, and logs. Although an assistant in the form of an Excel program was used for these simple tasks, which simplified filling out reports and calculations, all the necessary data was still in folders or on a computer in the office. What's more, there was no way to get real-time notifications of potential hazards and risks at the construction site [11-15].

The introduction of specialized software brought changes. Mobile apps and safety management software appeared on the market, allowing workers to get rid of the heavy paperwork and easily and quickly relay information about incidents that occurred on site. This transformation came about through the creation of a single digital system where all necessary data could be found in a convenient electronic format.

An example of such software is PLANRADAR, a cloud-based construction management solution that can be used on any portable device such as laptops, smartphones and tablets. All the necessary information for work is available when you visit the construction site. This software provides full functionality, including informing contractors about the progress of the work, assigning responsible persons, prescriptions, protocols, reports and drawing up documents from ready-made templates - all in real time.

3 Building information modelling

The introduction of BIM (Building Information Modeling) technology into the construction industry is really helping to improve the safety of the construction process and risk management. BIM is a digital model of a building or infrastructure that contains information about the geometry, materials, components, properties and interactions of structural elements.

One of the main advantages of BIM is the ability to identify potential errors and conflicts at the design stage. Thanks to three-dimensional models and data analysis, designers can
detect problematic areas, such as intersections of piping or electrical wiring, dimensional discrepancies and other conflicts that can lead to dangerous situations during the construction or operation of a building.

BIM also allows for virtual predictions and simulations to assess the impact of various factors on safety. Simulations help identify potential risks, such as hazardous working conditions, accessibility for firefighting or evacuation, non-compliance with safety standards, etc. This makes it possible to develop and take appropriate measures to prevent incidents and minimize risks.

The example of a construction company from the United States, which has reduced safety-related problems by 25% after the introduction of BIM, confirms the effectiveness of this technology. The use of digital models allowed them to analyze and compare different scenarios, highlight potential risks and take appropriate measures before the start of physical construction [16-25].

Thus, BIM is a powerful tool for forecasting and managing safety in construction. It helps to identify and solve problems early in the project, resulting in lower risks and safer workflows.

4 Smart Camera System

Using smart cameras for video analytics on construction sites can be an effective way to provide surveillance of the construction process. Installing such cameras, especially on tower cranes, allows you to cover a large area and obtain high-quality images. However, it should be noted that smart cameras have their own limitations. Unlike drones, which can move around in space and provide a view from different angles, cameras mounted on stationary objects have a fixed view and may have blind spots - areas that are outside their field of view. This can limit the ability to get complete visual information about an entire construction site.

Nevertheless, smart cameras still provide valuable information and can be used for a variety of purposes. They can detect security breaches, such as unauthorized access to a site or hazardous working conditions. They can also record video for later analysis and use in case of incidents or disputes.

Smart cameras also have a cost advantage over drones, making them more affordable for widespread use on construction sites.

Overall, smart cameras can be a useful addition to other construction site surveillance and security systems. They provide video analytics and help monitor construction processes, but they cannot completely replace other surveillance tools, such as drones, which provide a more flexible view.

5 Construction safety management software approach

Cloud-based solutions such as PLANRADAR software do offer several advantages that contribute to safer and more efficient processes at the construction site.

One of the main advantages is the ability to work in real time. This enables workers on the crew to get up-to-date data and better understand current processes. Updating data online helps prevent problems and inspections, which in turn improves project safety.

Cloud-based solutions also allow checklists to be created directly at the construction site. This makes it easy to assign responsibility for tasks and allows for real-time edits. This approach eliminates the need to do the work of collecting data on site and doing the paperwork in the office twice.

Generation of lists, reports, schedules and acceptance reports becomes more convenient thanks to cloud-based solutions. They provide ready-made templates and allow you to create
your own checklists. In addition, cloud-based solutions provide the ability to manage multiple sites simultaneously, making it easier to manage construction inspections.

The use of cloud solutions also helps improve construction safety and injury prevention. With fast information sharing and rapid communication between project participants, potential hazards can be responded to and acted upon in a timely manner.

Figure 1 with an example of the interface of the PLANRADAR software, it shows an intuitive and informative user interface, which facilitates the handling of data and ensures ease of use of the system.

Overall, using cloud-based solutions like PLANRADAR has a number of benefits, including saving time, increasing efficiency, and helping to prevent potential errors. They significantly contribute to safer construction sites, efficient construction control and reduced risk of injury through the rapid exchange of information.

![PLANRADAR software interface](image)

**Fig. 1. PLANRADAR software interface**

### 6 Building Information modelling Approach

The cloud-based approach and the ability for workers to report potential hazards really improves site safety and improves risk management for supervisors and managers.

Reducing adjustments and eliminating conflicts before work begins are important aspects of safety engineering. With cloud-based solutions and real-time information sharing, employees can detect inconsistencies and problems in advance, avoiding the need to redo work that's already been done. This reduces risk and makes the construction process more efficient.

Reducing the amount of hazardous work that crews do is also an important aspect of site safety. With the completeness of project information and the ability to communicate through cloud-based solutions, workers can receive all necessary instructions, directions and warnings regarding hazardous work. This helps reduce risks for workers and prevent possible accidents.

It's also worth noting that cloud-based solutions provide better communication between everyone involved in the project. Workers can share information, report problems and hazards, and supervisors and managers can promptly respond to these reports and take appropriate action. This promotes better communication and coordination between all parties involved in the construction process.
Overall, the use of cloud-based solutions and the active participation of workers in the exchange of information about possible hazards enables safety compliance at the construction site. This results in fewer adjustments, less hazardous work, better communication, and complete project information for all involved. As a result, construction safety is improved and potential risks and accidents are reduced.

Figure 2 shows the main function of BIM software - site view.

![BIM software](image)

**Fig. 2. – BIM software**

### 7 Smart Camera System

This system uses video analytics with specialized artificial intelligence, machine learning and advanced neural networks. It performs a detailed analysis of all processes and events in a certain area in real time, and ensures the safety of the construction site.

By training the neural network, it can automatically determine whether safety requirements are being followed, whether the worker is wearing the necessary protective equipment, or whether he or she is monitoring hazardous areas. If such problems are detected, responsible employees are notified accordingly. This allows you to quickly prevent potentially dangerous situations on construction sites.

Figure 3 shows a schematic of smart CCTV cameras.

![System diagram](image)

**Fig. 3. – System diagram**
8 Problems of implementation

While there are many solutions available to improve safety, there are several factors that can make it difficult to implement:

1) Some workers may deliberately ignore safety practices because they want to get the job done as quickly as possible or replace necessary resources with existing resources (misuse of equipment).

2) Many employers are not willing to invest heavily in such technology. Most of the workers on the construction site may be employed on temporary contracts and have no official status, which relieves the firm of responsibility for their injuries. This makes the purchase of expensive equipment unnecessary.

9 Results

Using all of the above solutions and approaches makes it possible to prevent risks, safety violations and dangerous situations before they occur. This significantly increases the efficiency, speed and quality of work on construction sites. This approach saves time and human resources that can be directed to other tasks not yet achieved by modern technologies in construction.

Planning and implementation of projects are taken to a new level. Construction companies are able to build and rebuild projects in months rather than years. These technologies are already available, but they are far from ubiquitous. With further development, the prices of such technologies will become much more affordable.

10 Conclusion

The use of such technology allows construction firms to achieve a high level of safety, turning construction sites into safe and comfortable work environments where workers are not at risk of injury or suffering from high levels of stress related to possible accidents. This promotes faster and more efficient completion of tasks and work plans.

With this approach, there may be a need for fewer workers on a construction site, as a lot of the physical and routine work will be done automatically or with specialized equipment. Thus, it will be sufficient to find specialists who will be responsible for the operational work with this equipment.

This approach offers the opportunity to optimize labor resources and increase productivity, freeing people from monotonous and dangerous tasks. In addition, concentrating equipment specialists allows for more efficient use and management of the equipment.

This approach to organizing work on construction sites has the potential to change familiar work processes and make construction safer, more efficient and more productive.

References

1. B. V. Malozyomov, et al., Energies 13, 4907 (2023)
2. B. V. Malozyomov, Micromachines 7, 1288 (2023)
4. V. O. Gutarevich, et al., Applied Sciences 8, 4671 (2023)
5. I. I. Bosikov, et al., Fire 3, 95 (2023)
6. B. V. Malozyomov, et al., Energies 9, 3909 (2023)