# ROLE OF DRONES AND COMPUTER VISION IN AUTOMATED SITE SAFETY MONITORING AND COMPLIANCE CHECKING

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## Abstract

Construction sites involve several safety risks, making regular and effective safety monitoring important for preventing accidents and maintaining safety compliance. Traditional methods such as manual inspection, supervisor monitoring, and CCTV are commonly used, but they may have limitations in terms of inspection speed, site coverage, and continuous monitoring. This study examines the use of drones and computer vision for automated construction site safety monitoring and compliance checking. Primary and secondary data were used in the study, with primary data collected through a structured questionnaire from construction professionals. The survey focused on current safety practices, awareness of modern technologies, drone-based monitoring, and acceptance of automated safety systems. The findings indicate that construction professionals generally have a positive view of drones and computer vision for safety monitoring. Respondents considered drones useful for faster inspection, better site coverage, improved hazard detection, and reducing human effort. The study also found strong support for integrating drones with computer vision to improve real-time monitoring and reduce construction safety risks. The case studies and literature reviewed further support the use of these technologies for automated inspection, hazard detection, safety compliance, and better decision-making. However, challenges such as high cost, lack of technical knowledge, and resistance to technological change may affect adoption. Overall, the study concludes that integrating drones with computer vision can provide an effective approach for improving construction site safety monitoring and creating a safer and more efficient working environment.

**Keywords:** Drones; Computer Vision; Construction Safety; Automated Safety Monitoring; Safety Compliance; Hazard Detection; Artificial Intelligence; Real-Time Monitoring; Construction Site Inspection.

## 1. INTRODUCTION

The construction industry plays an important role in the development of roads, bridges, buildings, highways, and other infrastructure. At the same time, construction sites are among the most hazardous working environments because workers are exposed to heavy machinery, falling objects, working at heights, moving equipment, and unsafe site conditions. Effective safety monitoring is therefore necessary to protect workers and reduce accidents.

Traditional construction safety monitoring mainly depends on supervisors and safety officers who physically inspect the site and check worker activities, safety equipment, machinery, and hazardous areas. Although manual inspection remains important, it can be time-consuming and may not provide continuous coverage, especially on large and complex construction sites. Human fatigue, limited visibility, and the difficulty of observing several activities at the same time can also affect the effectiveness of safety monitoring.


Figure 1: Why safety is important in construction? (Source – HLH Group)

The development of technologies such as drones, computer vision, and artificial intelligence provides new possibilities for improving construction safety. Drones can capture images and videos from different parts of a construction site and provide wider site coverage without requiring inspectors to physically enter dangerous areas. Computer vision can then analyse this visual data to identify workers, safety equipment, unsafe activities, and other potential hazards. This combination can support faster and more automated safety monitoring.

Integrating drones with computer vision can further improve the safety inspection process by combining aerial data collection with automated visual analysis. Such a system can help identify safety violations, support real-time monitoring, reduce dependence on manual observation, and provide information for faster safety decisions. Previous studies have also shown the potential of these technologies for hazard detection, safety compliance, worker monitoring, and construction site inspection.

However, the adoption of these technologies still faces challenges such as implementation cost, technical requirements, lack of skilled personnel, and resistance to technological change. Therefore, there is a need to understand how construction professionals view these technologies and how they can be practically used for safety monitoring. This study focuses on the role of drones and computer vision in automated construction site safety monitoring and compliance checking, with particular attention to monitoring efficiency, hazard detection, safety compliance, and improved decision-making.

## 2. REVIEW OF LITERATURE

Shrigandhi and Gengaje (2025) developed the CSOD-24 dataset for construction safety monitoring using deep learning. The study provided real construction video data covering workers, helmets, and heavy machinery. The work is useful for developing computer vision models, although larger and more diverse datasets are still needed for different site conditions.

Hou et al. (2023) developed a computer vision-based system for calculating and visualizing safety risks on construction sites. The study showed that automated risk assessment can support safety decisions and provide results close to expert assessment. However, the study did not focus on collecting real-time data through drones.

Adeyemo (2024) examined the use of modern technologies such as drones, sensors, and wearable devices for improving construction safety. The study showed that technology can improve hazard monitoring and reduce safety problems. However, it provides a broader discussion rather than focusing specifically on an integrated drone and computer vision system.

Ashour et al. (2016) explored the use of drones for construction site inspection and regulation. The study showed that drones can support remote inspection, reduce manual effort, and improve monitoring efficiency. However, the system did not include the advanced computer vision techniques that are available today.

M. G. S. (2022) studied multi-sensor drone platforms for safety and quality inspection in active construction zones. The use of visual cameras, thermal imaging, and LiDAR improved inspection and defect detection. However, the complexity and cost of such systems may limit their use on smaller construction projects.

Poudel et al. (2026) proposed an advanced approach combining autonomous drones, computer vision, and large language models for construction safety management. The system can detect safety violations and support contextual decision-making. Although promising, the approach is technically complex, showing the need for simpler solutions that can be practically adopted on construction sites.

Hansamal et al. (2025) examined computer vision-based workforce tracking for safety compliance monitoring. The study focused on tracking workers and identifying safety violations such as missing PPE. The findings support the use of computer vision for continuous worker monitoring, although fixed cameras may provide limited coverage on large and changing construction sites.

Kavatagimath et al. (2025) developed an automated construction safety inspection system using computer vision. The study showed that automated detection can reduce inspection time and provide faster safety information. However, the system mainly focuses on visual analysis, creating an opportunity to improve site coverage through drone-based data collection.

Pavithra et al. (2025) studied AI-based crowd monitoring with a focus on helmet detection. The research shows that computer vision can automatically monitor basic safety compliance without continuous human observation. However, helmet detection alone cannot cover the wide range of hazards present on construction sites.

Mohy et al. (2025) developed a deep learning-based computer vision model for automated safety compliance. The study focused on improving the detection of safety risks and supporting proactive safety management. However, practical integration with drone-based real-time monitoring was not the main focus of the research.

Dimaano and Alon (2023) used instance segmentation and data augmentation to improve construction safety compliance detection. Their work shows that better training techniques can improve computer vision performance under different site conditions. However, the study mainly focuses on model development rather than complete drone-based monitoring.

Zhussupbekov et al. (2025) investigated the combined use of computer vision and drones for construction safety monitoring. The study supports the idea that integrating aerial monitoring with AI can improve safety inspection and hazard detection. However, the implementation of such integrated systems may still face cost and technical challenges.

Yi and Qu (2021) examined drone-based image processing for construction safety, transportation, and progress management. Their study showed that drones can provide useful visual information for inspection and monitoring while reducing the need for physical site observation. However, advanced automated safety compliance analysis was not the main focus.

Jiang et al. (2023) demonstrated the use of drones and computer vision for automated inspection of a large reflector surface. Although the application was outside construction worker safety, the study showed that drone-based visual inspection can identify defects efficiently. This provides useful support for applying similar inspection concepts to construction safety.

Bhise (2024) examined the use of drones and unmanned vehicles for construction monitoring and reporting. The study highlighted the benefits of aerial data collection, monitoring, and automated reporting. However, the research focused more on general construction monitoring and did not specifically address computer vision-based safety compliance.

Kavatagimath et al. (2025) further highlighted the potential of computer vision for automated construction safety inspection. The study showed that automated systems can support faster identification of safety hazards and reduce dependence on manual inspection. This supports the need for technology-based safety monitoring in modern construction projects.

Ukamaka et al. (2025) studied automated construction monitoring using drones and digital twins. The study showed that drone-based data can improve monitoring efficiency, support early identification of problems, and assist project decision-making. The research demonstrates the value of combining aerial monitoring with digital technologies for safer and more efficient construction management.

Yi and Qu (2021) also highlighted the importance of drone-based image processing for construction site monitoring. Their work showed that UAVs can provide continuous visual information for inspection, safety, and progress management. The study provides a useful foundation for further development of drone-based systems with computer vision and automated safety compliance checking.

**Research Gap**

The existing literature shows that drones, computer vision, and deep learning can improve construction safety monitoring and hazard detection. However, most studies focus on individual technologies or specific safety tasks rather than a simple integrated system. There is also limited research on practical real-time compliance checking using drone footage and computer vision. Therefore, this study focuses on integrating drones and computer vision for automated safety monitoring, with the aim of improving inspection efficiency, reducing human error, and supporting faster safety decisions.

## 3. OBJECTIVE OF THE STUDY

The objectives of the study are:

1. To study how drone-based imaging supports real-time safety monitoring on construction sites.
2. To analyse the use of computer vision techniques for detecting unsafe worker behaviour, equipment misuse, and hazardous conditions.
3. To collect and check data by integrating drone footage and computer vision models for automated safety compliance checking.
4. To evaluate and compare the accuracy and reliability of automated alerts with manual safety inspections.
5. To assess the overall impact of automated drone monitoring on reducing accidents, improving site efficiency, and supporting safety decision-making.

## 4. METHODOLOGY

### Research Design

This study follows a descriptive and analytical research design to examine the role of drones and computer vision in automated construction site safety monitoring. The study uses both primary and secondary data to understand existing safety practices and the potential benefits of technology-based safety monitoring.

### Data Collection

### Primary Data

Primary data were collected through a structured questionnaire from construction professionals. A sample size of **200 respondents** was considered, including site engineers, supervisors, construction workers, and safety officers. The questionnaire covered current safety practices, awareness of drones and computer vision, drone-based safety monitoring, and acceptance of automated safety systems. The questionnaire was distributed through online and offline methods, with more than 50% valid responses considered for analysis.

### Secondary Data

Secondary data were collected from research papers, journals, conference proceedings, books, and other academic sources. These sources were used to understand previous research, existing technologies, and applications of drones and computer vision in construction safety.

### Sampling Method

Convenience sampling was used to select respondents who were available and connected with the construction industry. This helped collect opinions from professionals and workers with different roles and experiences in construction safety.

**Data Analysis**

The collected questionnaire data were analysed using frequency and percentage analysis. The results were presented through tables and charts and explained through simple interpretations. The survey findings were also compared with relevant literature and case studies to understand the practical role of drones and computer vision in improving construction safety.

**Research Procedure**

The research was carried out through a series of steps, beginning with a review of existing literature and preparation of the questionnaire. After collecting the survey responses, the data were analysed and interpreted. Relevant case studies were then reviewed to compare the practical applications of drones and computer vision with the survey findings. This helped in developing an overall understanding of automated safety monitoring and compliance checking in construction.

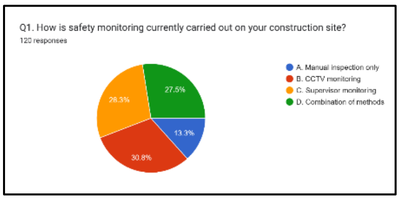
## 5. DATA ANALYSIS

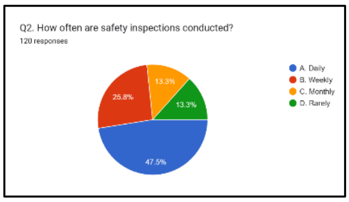
This section presents the analysis of the survey data collected from construction professionals. The analysis focuses on current safety practices, awareness of drones and computer vision, drone-based safety monitoring, and acceptance of automated safety systems. The findings are presented using frequency and percentage analysis to understand the respondents' views and identify the potential role of technology in improving construction site safety.

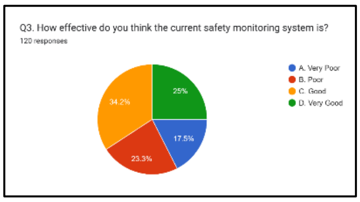
**Current Safety Practices**

| Question | Response Option | Frequency | Percentage (%) |
|---|---|---|---|
| **Q1. How is safety monitoring currently carried out on your construction site?** | A. Manual inspection only | 16 | 13.3 |
| | B. CCTV monitoring | 37 | 30.8 |
| | C. Supervisor monitoring | 34 | 28.3 |
| | D. Combination of methods | 33 | 27.5 |
| **Q2. How often are safety inspections conducted?** | A. Daily | 57 | 47.5 |
| | B. Weekly | 31 | 25.8 |
| | C. Monthly | 16 | 13.3 |
| | D. Rarely | 16 | 13.3 |
| **Q3. How effective do you think the current safety monitoring system is?** | A. Very Poor | 21 | 17.5 |
| | B. Poor | 28 | 23.3 |

| | | | |
|---|---|---|---|
| | C. Good | 41 | 34.2 |
| | D. Very Good | 30 | 25.0 |



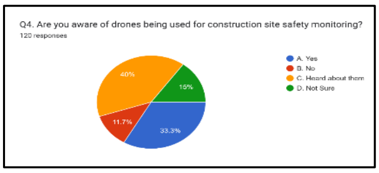



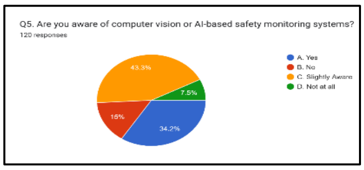



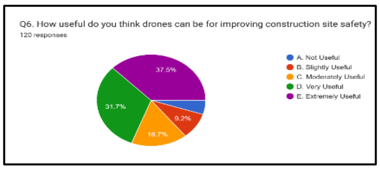

The findings show that **30.8%** of respondents reported CCTV monitoring as the current safety monitoring method, followed by supervisor monitoring at **28.3%** and a combination of methods at **27.5%**. Only **13.3%** relied on manual inspection alone. Regarding inspection frequency, **47.5%** reported daily inspections, **25.8%** weekly inspections, and **13.3%** each monthly or rarely. For effectiveness, **34.2%** rated the current system as good and **25.0%** as very good, while **23.3%** rated it poor and **17.5%** very poor. Overall, regular monitoring is common, but there is still scope for improving its consistency and effectiveness.

**Awareness of Technology**

| Question | Response Option | Frequency | Percentage (%) |
|---|---|---|---|
| **Q4. Are you aware of drones being used for construction site safety monitoring?** | A. Yes | 40 | 33.3 |
| | B. No | 14 | 11.7 |
| | C. Heard about them | 48 | 40.0 |
| | D. Not Sure | 18 | 15.0 |
| **Q5. Are you aware of computer vision or AI-based safety monitoring systems?** | A. Yes | 41 | 34.2 |
| | B. No | 18 | 15.0 |
| | C. Slightly Aware | 52 | 43.3 |
| | D. Not at all | 9 | 7.5 |
| **Q6. How useful do you think drones can be for improving construction site safety?** | A. Not Useful | 6 | 5.0 |
| | B. Slightly Useful | 11 | 9.2 |
| | C. Moderately Useful | 20 | 16.7 |
| | D. Very Useful | 38 | 31.7 |
| | E. Extremely Useful | 45 | 37.5 |



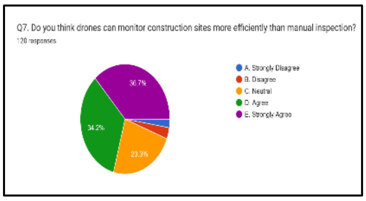



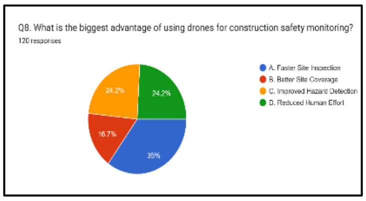



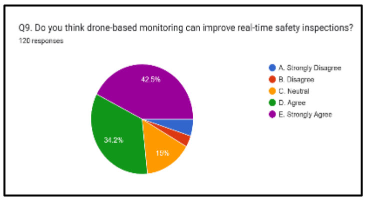

The results indicate that **40.0%** of respondents had heard about drone-based safety monitoring, while **33.3%** were already aware of it. For computer vision and AI-based safety monitoring, **43.3%** were slightly aware and **34.2%** were aware. Regarding usefulness, **37.5%** considered drones extremely useful and **31.7%** considered them very useful, while **16.7%** rated them moderately useful. These findings show growing awareness and a generally positive perception of technology-based safety solutions.

**Drone-Based Safety Monitoring**

| **Question** | **Response Option** | **Frequency** | **Percentage (%)** |
|---|---|---|---|
| **Q7. Do you think drones can monitor construction sites more efficiently than manual inspection?** | A. Strongly Disagree | 3 | 2.5 |
| | B. Disagree | 4 | 3.3 |
| | C. Neutral | 28 | 23.3 |
| | D. Agree | 41 | 34.2 |
| | E. Strongly Agree | 44 | 36.7 |
| **Q8. What is the biggest advantage of using drones for construction safety monitoring?** | A. Faster Site Inspection | 42 | 35.0 |
| | B. Better Site Coverage | 20 | 16.7 |
| | C. Improved Hazard Detection | 29 | 24.2 |
| | D. Reduced Human Effort | 29 | 24.2 |
| **Q9. Do you think drone-based monitoring can improve real-time safety inspections?** | A. Strongly Disagree | 6 | 5.0 |
| | B. Disagree | 4 | 3.3 |
| | C. Neutral | 18 | 15.0 |
| | D. Agree | 41 | 34.2 |
| | E. Strongly Agree | 51 | 42.5 |



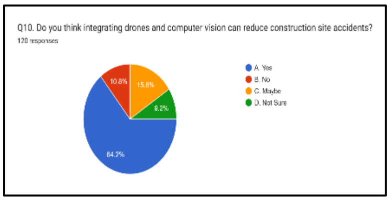



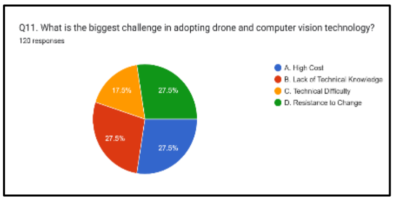



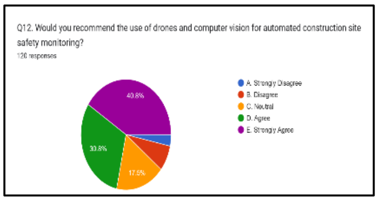

The findings show that **36.7%** strongly agreed and **34.2%** agreed that drones can monitor construction sites more efficiently than manual inspection. The main advantage identified was faster site inspection at **35.0%**, followed by improved hazard detection and reduced human effort at **24.2%** each. Furthermore, **42.5%** strongly agreed and **34.2%** agreed that drones can improve real-time safety inspections. Overall, the results indicate strong support for drone-based monitoring.

**Acceptance of Automated Safety Systems**

| Question | Response Option | Frequency | Percentage (%) |
|---|---|---|---|
| **Q10. Do you think integrating drones and computer vision can reduce construction site accidents?** | A. Yes | 77 | 64.2 |
| | B. No | 13 | 10.8 |
| | C. Maybe | 19 | 15.8 |
| | D. Not Sure | 11 | 9.2 |
| **Q11. What is the biggest challenge in adopting drone and computer vision technology?** | A. High Cost | 33 | 27.5 |
| | B. Lack of Technical Knowledge | 33 | 27.5 |
| | C. Technical Difficulty | 21 | 17.5 |
| | D. Resistance to Change | 33 | 27.5 |
| **Q12. Would you recommend the use of drones and computer vision for automated construction site safety monitoring?** | A. Strongly Disagree | 4 | 3.3 |
| | B. Disagree | 9 | 7.5 |
| | C. Neutral | 21 | 17.5 |
| | D. Agree | 37 | 30.8 |
| | E. Strongly Agree | 49 | 40.8 |




The results show that **64.2%** of respondents believed that integrating drones and computer vision can reduce construction site accidents, while **15.8%** selected maybe. For adoption challenges, **27.5%** each identified high cost, lack of technical knowledge, and resistance to change, while **17.5%** selected technical difficulty. Regarding recommendation, **40.8%** strongly agreed and **30.8%** agreed with using drones and computer vision for automated safety monitoring. This indicates strong acceptance, although practical barriers still need to be addressed.

**Overall Analysis**

Overall, the survey results show a positive attitude towards drones and computer vision in construction safety monitoring. The majority supported drone-based monitoring, with 70.9% either agreeing or strongly agreeing that drones can be more efficient than manual inspection, while 76.7% agreed or strongly agreed that drones can improve real-time safety inspections. Similarly, 71.6% agreed or strongly agreed with recommending drones and computer vision for automated safety monitoring. However, the findings also highlight barriers such as cost, lack of technical knowledge, and resistance to change, which should be considered for successful implementation.

## 6. CASE STUDIES ON DRONES AND COMPUTER VISION IN CONSTRUCTION SAFETY

The case studies reviewed in this section show that drones, computer vision, deep learning, and other automated technologies can improve construction safety monitoring. Although the studies use different technologies and methods, they share a common objective of reducing dependence on manual inspection and improving the speed of identifying safety risks.

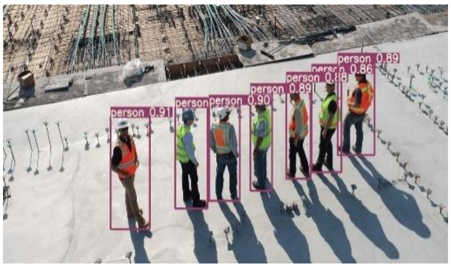
**Case Study 1: Automated Construction Safety Inspection Using Computer Vision**

Automated construction safety inspection refers to the use of computer-based systems to identify safety violations from construction site images or videos. Such systems are designed to reduce dependence on continuous manual inspection and provide faster identification of unsafe conditions.

Kavatagimath et al. (2025) demonstrated the usefulness of computer vision for automated construction safety inspection. The study showed that visual data can be analysed to identify workers, safety equipment, and potential safety violations. The main learning is that computer vision can improve monitoring speed, consistency, and safety compliance. However, the system mainly depends on camera-based data, which limits coverage in large and complex sites. This creates an opportunity to combine computer vision with drones for wider site monitoring.

**Case Study 2: Automated Construction Monitoring Using Drone Technology and Digital Twins**

Drone-based construction monitoring involves using UAVs to capture aerial images and videos of a project, while digital twin technology creates a virtual representation of the actual construction site. This combination allows site conditions and construction progress to be monitored remotely and more efficiently.



Ukamaka et al. (2025) showed that drone data can be integrated with digital twin models to improve construction monitoring and decision-making. The study highlights the ability of drones to cover large areas and provide updated site information without requiring continuous physical inspection. However, the main focus was on construction monitoring and digital modelling rather than detailed safety compliance. Integrating computer vision with the drone data could therefore make the system more useful for automated safety monitoring.

**Case Study 3: Worker Safety Monitoring Using UAVs and Deep Learning**

Worker safety monitoring focuses on identifying unsafe worker activities and checking whether workers follow required safety practices. UAVs provide an aerial view of the site, while deep learning techniques can analyse the captured images to identify workers, PPE, and other safety-related conditions.

Awolusi et al. (2022) showed that UAVs and deep learning can support automated monitoring of worker safety on construction sites. The approach provides wider coverage than conventional observation and can help identify safety violations more quickly. The study also highlights the importance of real-time analysis for preventive safety management. However, system performance can be affected by image quality, lighting, environmental conditions, and the availability of suitable training data.

**Case Study 4: Impact of Unmanned Aerial Systems on Construction Safety Performance**

Unmanned Aerial Systems provide a practical way of observing construction activities from above without requiring safety personnel to physically access every part of a site. This can be particularly useful on large or high-risk construction projects where continuous ground-level inspection is difficult.

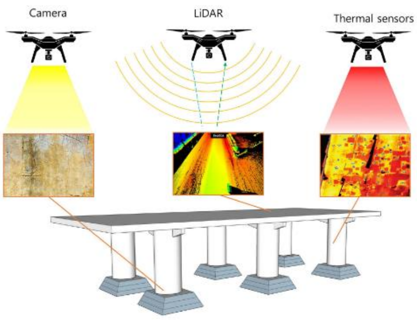
Antar et al. (2023) examined how UAS-based monitoring can influence construction safety performance. The findings indicate that drone monitoring can support better hazard identification and reduce unsafe worker behaviour. The study provides useful evidence that drones can contribute directly to safety improvement rather than being limited to progress monitoring. However, the approach does not fully integrate computer vision for automatic detection, which remains an important area for further development.

**Case Study 5: Deep Learning-Based Computer Vision for Safety Compliance**


Automated safety compliance systems use artificial intelligence to check whether construction activities and workers are following safety requirements. Deep learning models can analyse large amounts of visual information and identify multiple safety-related conditions more consistently than manual observation.

Mohy et al. (2025) developed a deep learning-based computer vision approach for automated safety compliance in construction environments. The study highlights the ability of advanced models to detect safety issues and support proactive safety management. The key learning is that improved computer vision models can provide more reliable detection and reduce false alarms. However, these systems require substantial training data, computational resources, and technical expertise, making practical integration with drone-based monitoring an important next step.

**Case Study 6: Integrated Drone and AI-Based Safety Monitoring**




An integrated drone and AI safety system combines aerial data collection with artificial intelligence to monitor both site conditions and worker safety. Such systems can provide continuous observation and generate alerts when safety violations or hazardous activities are detected.

Zhussupbekov et al. (2025) presented an integrated approach using drones and AI for construction safety monitoring. The system considered several safety aspects, including PPE detection, worker identification, and unsafe behaviour. The study demonstrates that combining aerial monitoring with AI can provide more comprehensive safety management than using either technology alone. However, advanced features can increase system cost, complexity, and privacy concerns. A simpler drone and computer vision framework may therefore be more practical for wider construction use.

**Case Study 7: Multi-Sensor Drone Platforms for Safety and Quality Inspection**

Multi-sensor drone platforms use different sensing technologies, such as visual cameras, thermal imaging, and LiDAR, to collect detailed information about construction sites. These systems can support both safety and quality inspections while reducing the need for inspectors to enter difficult or hazardous areas.

M. G. S. (2022) highlighted the potential of multi-sensor drones for improving construction inspection. The study shows that combining different sensors can provide more detailed information and improve inspection efficiency and accuracy. However, these systems involve higher equipment costs and greater technical complexity, which may limit their use on smaller projects. This suggests that a simpler combination of conventional drones and computer vision could offer a more practical solution for automated safety monitoring.

## 7. RESULTS AND DISCUSSION

The survey findings show that construction sites are using different methods for safety monitoring, including CCTV, supervisor monitoring, and manual inspection. Safety inspections are also carried out regularly at many sites. However, the responses indicate that the existing systems are not equally effective everywhere. This suggests that while conventional safety practices remain important, there is still a need for more continuous and reliable monitoring methods.

The findings also show that construction professionals have a growing awareness of modern technologies such as drones, computer vision, and artificial intelligence. Respondents generally viewed drones as useful for improving construction site safety, particularly because they can provide a wider view of the site and support faster inspection. This indicates that technology-based safety solutions are becoming more acceptable within the construction industry.

A strong positive response was also observed towards drone-based safety monitoring. Respondents considered faster site inspection, improved hazard detection, and reduced human effort as important advantages of using drones. The findings suggest that drones can support safety officers by covering areas that may be difficult or time-consuming to inspect manually. Real-time monitoring can also help in identifying unsafe conditions at an earlier stage.

The case studies support these survey findings and provide practical evidence of the use of drones and computer vision in construction safety. Studies involving computer vision demonstrate that automated systems can identify workers, PPE, and safety violations, while UAV-based studies show that drones can provide wider site coverage and faster data collection. The reviewed studies also indicate that combining aerial monitoring with artificial intelligence can support better safety decisions and reduce dependence on manual observation.

At the same time, both the survey and case studies highlight several challenges. High implementation cost, lack of technical knowledge, system complexity, training requirements, and resistance to technological change can make adoption difficult. Advanced systems using multiple sensors or complex AI models may provide better capabilities, but they may not always be practical for smaller construction projects. Therefore, simplicity and ease of implementation are important considerations.

Overall, the findings suggest that drones and computer vision can complement traditional safety management rather than completely replace safety professionals. Drones can collect site information, while computer vision can analyse the captured data and identify possible safety violations. A practical and cost-effective combination of these technologies can improve monitoring, support faster responses, reduce human error, and contribute to better construction site safety and compliance.

## 8. CONCLUSION

The study concludes that the integration of drones and computer vision has strong potential to improve construction site safety monitoring and compliance checking. The findings from the survey and case studies show that traditional safety monitoring methods, although still important, have limitations in terms of site coverage, continuous observation, inspection time, and dependence on human attention. Drones can help overcome these limitations by capturing wider and more frequent visual information from construction sites, while computer vision can analyse this information to identify workers, PPE, unsafe behaviour, hazards, and other safety violations. The overall findings also indicate that construction professionals have a positive attitude towards technology-based safety monitoring and recognise the benefits of faster inspection, real-time monitoring, improved hazard detection, and reduced human effort. At the same time, challenges such as implementation cost, lack of technical knowledge, system complexity, and resistance to change need to be addressed before wider adoption. The reviewed case studies further support the practical value of combining UAVs, artificial intelligence, deep learning, and computer vision for improving construction safety. Therefore, a simple, practical, and cost-effective drone and computer vision-based system can be used as a supportive tool alongside existing safety practices to improve monitoring, reduce human error, support faster decision-making, and create a safer and more compliant construction environment.

## 9. FUTURE SCOPE

Future studies can focus on developing a simple and cost-effective system that combines drones with computer vision for real-time safety monitoring. The system can be improved to detect more types of safety violations and provide instant alerts to safety officers. Further research can also test the system on larger construction sites and under different environmental conditions to improve its reliability and practical use.

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