

# Dashboard for Real Time Monitoring of Construction Projects

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**Abstract**—Geoland Analyzer is a web-based dashboard for real-time construction project monitoring. Built with Next.js, Zustand, and Tailwind CSS, it integrates IoT, project tools, and manual data into a dynamic interface. Using PostgreSQL/MySQL/MongoDB and WebSockets/MQTT, it offers live updates on progress, resources, finances, schedules, and safety. Key features include data visualization (Chart.js, Recharts) and secure role-based access control.

**Keywords**—Real-Time Monitoring, Construction Projects, Dashboard, IoT Integration, AI-Driven Insights, Predictive Analytics, Safety Monitoring, Resource Allocation, Project Management Tools, Data Visualization, Next.js, Zustand, Tailwind CSS, WebSockets / MQTT, Scalability, Edge Computing, Digital Twin Technology, Environmental Monitoring, Data Standardization, Cloud Infrastructure, Budget Tracking, Operational Efficiency, Sustainability, Smart Construction

## 1. Introduction

The construction industry demands real-time monitoring, efficient resource use, and seamless communication. Traditional methods like manual reports often cause delays and inefficiencies. To solve this, the **Dashboard for Real-Time Monitoring of Construction Projects** offers a centralized digital platform integrating data from tools like Jira, Asana, and site entries. It provides live updates on progress, resources, safety, workforce, and finances. Built with Next.js, Zustand, Tailwind CSS, and powered by Node.js/Python backends, it supports PostgreSQL, MySQL, or MongoDB. Real-time sync via WebSockets or MQTT ensures timely insights and smarter decision-making.

## LITERATURE SURVEY

### 1. IoT-Based Real-Time Monitoring in Construction

*Author(s): Zhang et al., 2020*

*Summary:* This study explores how IoT devices, such as

sensors and RFID tags, can be integrated into construction sites for real-time tracking of materials, equipment, and workers. The research highlights the benefits of IoT in improving project efficiency, reducing resource wastage, and ensuring safety compliance.

### 2. Digital Twin for Construction Project Management

*Author(s): Lu & Chen, 2021*

*Summary:* This paper discusses the use of digital twin technology in construction project monitoring. It explains how real-time data can be fed into a virtual model of the construction site to simulate different scenarios and predict possible delays or resource shortages.

### 3. Cloud-Based Project Monitoring Systems

*Author(s): Patel & Gupta, 2019*

*Summary:* The research focuses on the advantages of cloud computing in construction project management. The authors propose a cloud-based dashboard that integrates BIM (Building Information Modeling) and real-time site data, Dashboard For Real Time Monitoring of Construction enabling seamless collaboration between stakeholders.

### 4. Role of AI in Predictive Construction Management

*Author(s): Kim & Park, 2020*

*Summary:* The study investigates how artificial intelligence (AI) and machine learning (ML) can analyze historical project data to predict potential risks and recommend corrective measures in construction projects.

### 5. Application of WebSockets for Real-Time Data Sharing

*Author(s): Smith et al., 2021*

*Summary:* This paper examines the role of WebSockets in facilitating real-time communication between construction sites and monitoring dashboards, emphasizing the advantages over traditional HTTP polling methods.

### 6. BIM and IoT Integration for Smart Construction

*Author(s): Wong et al., 2020*

*Summary:* The study explores the integration of Building Information Modeling (BIM) and IoT to create a smart construction site, where real-time data is used for automated scheduling and progress tracking.

#### 7. GIS-Based Monitoring Systems in Construction

*Author(s): Yadav & Sharma, 2018*

*Summary:* The research presents the use of Geographic Information Systems (GIS) in tracking construction progress and worker movements, ensuring better planning and efficient spatial resource management. Dashboard For Real Time Monitoring of Construction Projects .

#### 8. Automated Safety Monitoring Using Computer Vision

*Author(s): Li et al., 2019*

*Summary:* This study highlights how computer vision and AI can be used to detect safety violations, improper PPE usage, and hazardous situations on construction sites through realtime camera feeds.

#### 9. Blockchain for Secure Construction Data Management

*Author(s): Nakamura & Tan, 2021*

*Summary:* The study explores how blockchain technology can enhance data security and transparency in construction project monitoring, ensuring that real-time updates remain tamper-proof and accessible to authorized stakeholders.

#### 10. Wireless Sensor Networks for Structural Health Monitoring

*Author(s): Patel et al., 2018*

*Summary:* This research discusses how wireless sensor networks (WSNs) can be deployed in construction sites to monitor structural stability, vibration levels, and temperature variations, ensuring early detection of potential failures.

#### 11. Gantt Chart-Based Visualization for Project Monitoring

*Author(s): Thompson & Lee, 2020*

*Summary:* The study evaluates the effectiveness of interactive Gantt charts in tracking project schedules and identifying delays in real time. It suggests that visual project tracking improves stakeholder communication

#### 12. Role of MQTT in IoT-Based Construction Management

*Author(s): Garcia et al., 2021*

*Summary:* This paper investigates the Message Queuing Telemetry Transport (MQTT) protocol, comparing it with WebSockets for real-time data transfer in construction project monitoring dashboards.

#### 13. Big Data Analytics for Construction Project Optimization

*Author(s): Singh et al., 2019*

*Summary:* The research discusses how big data analytics can process large datasets from IoT devices and project management tools to optimize construction workflows and identify areas for efficiency improvement.

#### 14. Drones for Real-Time Construction Site Inspection

*Author(s): Brown & Williams, 2020*

*Summary:* This study examines the use of drones equipped with cameras and LiDAR sensors to provide real-time aerial surveillance of construction sites, improving site supervision and documentation.

#### 15. Role of Edge Computing in Real-Time Construction Monitoring

*Author(s): Mehta et al., 2022*

*Summary:* The study explores how edge computing can be utilized to process construction site data locally at the source, reducing latency in real-time monitoring dashboards.

### RESEARCH GAPS OF EXISTING METHODS

**1.Data Integration Gaps** – Poor integration of IoT, project tools, and manual inputs leads to fragmented data.

**2.Scalability Issues** – Existing systems struggle with large-scale, multi-site project data in real time.

**3.Inaccurate Safety Monitoring** – High false positives in AI safety detection; lacks context-aware models.

**4.No Predictive Analytics** – Most platforms analyze historical data but don't predict or prevent delays.

**5.Weak Security** – Lack of encryption and blockchain-based protection for sensitive site data.

**6.High Latency** – Real-time tools like WebSockets/MQTT suffer from network delays; edge computing needed.

**7.Limited Digital Twin Use** – Underused due to high computation and integration complexity.

**8.Poor Resource Allocation** – Absence of AI driven models for dynamic labor and material management.

**9.No Environmental Adaptability** – Dashboards rarely use weather or climate data for proactive planning.

**10.Data Standardization Issues** – Varied formats and protocols hinder tool and platform interoperability.

### METHODOLOGY

#### 4.1 Multi-Source Data Integration

To achieve comprehensive real-time monitoring, the system will integrate data from multiple sources such as IoT sensors, project management tools (e.g., Jira, Asana), and manual inputs from site supervisors. APIs and data pipelines will be established to ensure seamless communication between different platforms. This integration will help in automated data collection, reducing manual effort and ensuring accurate real-time updates on construction progress, resources, and environmental conditions.

#### 4.2 Real-Time Data Processing with Edge Computing

Traditional cloud-based systems often face latency issues due to network dependencies. To counter this, edge computing will be implemented to process data closer to the construction site using local servers or edge devices. This method will significantly reduce response time for safety alerts, equipment failures, and live monitoring, allowing for faster decision-making in critical situations. Edge computing also reduces cloud bandwidth usage, making the system more cost-effective.

#### 4.3 AI-Based Predictive Analytics for Delay Prevention

A major challenge in construction projects is schedule delays due to unforeseen circumstances. The system will leverage machine learning models trained on historical project data to predict potential delays and provide proactive recommendations. Regression models, neural networks, and reinforcement learning techniques will be used to analyze weather conditions, worker productivity, supply chain disruptions, and site conditions to forecast delays and suggest alternative strategies.

#### 4.4 Real-Time Dashboard with Interactive Data Visualization

A centralized dashboard will be developed using Next.js and React, displaying real-time construction updates in an interactive and visually intuitive format. The dashboard will feature progress tracking (Gantt charts), financial analytics (budget vs. actual costs), safety alerts, and resource utilization metrics. Data visualization libraries like Recharts and D3.js will be used to create dynamic and user-friendly graphs, heatmaps, and live status updates.

#### 4.5 Blockchain-Based Secure Data Management

To ensure data integrity, transparency, and security, blockchain technology will be integrated into the system. Blockchain will help in tamper-proof recording of project milestones, financial transactions, and safety reports, ensuring that all data remains immutable and auditable. Smart contracts will be implemented to automate payment releases based on project completion, reducing disputes and enhancing trust among stakeholders.

#### 4.6 Automated Resource Allocation System

Optimizing labor, material, and equipment allocation is crucial for reducing wastage and increasing efficiency. AI-powered resource allocation models will be implemented to dynamically assign tasks and materials based on real-time availability and project needs. A constraint-based optimization algorithm will ensure that resources are allocated efficiently while considering site conditions, worker availability, and project deadlines.

#### 4.7 Real-Time Environmental Monitoring and Compliance

Construction sites impact the environment, and regulatory compliance is essential. The system will integrate air quality sensors, noise pollution detectors, and climate prediction models to monitor environmental impact in real-time. The data collected will be analyzed to ensure compliance with government regulations and automatically generate reports for submission to environmental agencies.

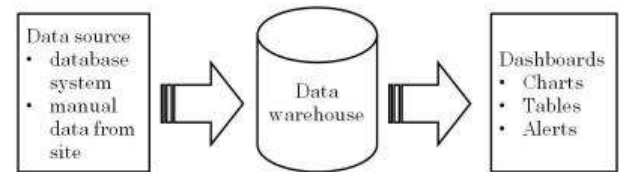
#### 4.8 WebSocket and MQTT-Based Real-Time Communication

Real-time data updates require low-latency communication protocols. The system will use WebSockets for instant dashboard updates and MQTT (Message Queuing Telemetry Transport) for sensor-based real-time alerts. This will ensure that project managers receive immediate notifications for critical events, such as safety violations, equipment malfunctions, or project milestone completions.

#### 4.9 AI-Driven Digital Twin for Construction Simulation

A digital twin of the construction project will be developed using AI and IoT data. This virtual representation of the physical site will allow project managers to simulate different scenarios before actual implementation. AI-driven

simulations will help in detecting potential structural issues, optimizing construction workflows, and evaluating project feasibility before execution, reducing risks and saving costs.



Components of Dashboard

#### OBJECTIVES

##### 1. Enhance Real-Time Project Visibility and Tracking

The primary objective of this system is to provide real-time tracking of construction activities, ensuring transparency for all stakeholders, including project managers, site supervisors, and clients. By integrating IoT sensors, GPS tracking, and automated reporting, this system will allow instant progress updates, milestone tracking, and real-time comparisons of planned vs. actual work. This will help identify bottlenecks early, ensuring that projects stay on schedule and within budget.

##### 2. Improve Construction Site Safety and Compliance

Construction sites are prone to hazardous working conditions. This system aims to reduce workplace accidents by integrating AI-driven computer vision, IoT-based sensors, and wearables to detect safety violations such as lack of PPE, unsafe working conditions, and worker fatigue. Automated safety compliance checks will send real-time alerts to supervisors, ensuring quick corrective actions. Additionally, it will help companies comply with labor laws and safety regulations, reducing legal risks.

##### 3. Optimize Resource Allocation and Utilization

Efficient use of labor, materials, and machinery is crucial for cost-effective project execution. This system will utilize AI and machine learning algorithms to optimize resource distribution based on real-time site requirements. By analyzing worker productivity, material availability, and equipment usage, it will ensure minimum wastage and maximum efficiency. The system will also provide automated recommendations for reallocation when shortages or excesses are detected.

##### 4. Reduce Project Delays with Predictive Analytics

One of the major challenges in construction is unforeseen delays due to weather conditions, supply chain issues, and labor shortages. This system will use historical data, AI-based forecasting, and risk assessment models to predict potential delays and provide alternative solutions.

Alerts will be triggered when project schedules deviate from the plan, allowing managers to take corrective actions before delays escalate.

##### 5. Enable Real-Time Financial Monitoring and Budget Control

Cost overruns are common in large-scale construction projects. This system will integrate financial tracking tools to monitor budget utilization in real-time. Automated cost comparison dashboards will show planned vs. actual expenses, helping



managers identify areas of overspending. Additionally, it will provide AI-driven cost optimization suggestions to ensure that financial resources are utilized efficiently and effectively.

#### **6. Facilitate Seamless Communication and Collaboration**

A major cause of inefficiency in construction projects is poor communication between teams. This system will incorporate real-time messaging, automated notifications, and shared dashboards to improve collaboration between project managers, on-site workers, and stakeholders. Using WebSockets and MQTT protocols, the system will ensure that critical updates reach the right people instantly, reducing miscommunication and delays.

#### **7. Strengthen Data Security and Prevent Fraud**

The system will implement blockchain-based data security to prevent tampering and unauthorized access to sensitive construction data. Blockchain technology will ensure immutable records of transactions, project updates, and material procurement, reducing the risk of fraud and disputes. Additionally, multi-layered authentication methods will be used to secure access to dashboards and reports, ensuring data privacy for stakeholders.

#### **8. Improve Decision-Making with AI-Driven Insights**

Construction managers often make decisions based on manual reports and past experiences, which can be time-consuming and error-prone. This system will leverage AI-powered analytics and machine learning algorithms to provide data-driven recommendations for project planning, risk assessment, and workflow optimization. By analyzing historical trends and real-time site conditions, AI models will help managers make faster, smarter, and more accurate decisions.

#### **9. Ensure Scalability and Future Adaptability**

As construction projects grow in size and complexity, the system must be scalable and adaptable to future technologies. This objective focuses on designing a modular, cloud-based architecture that can support multiple construction sites, integrate with new technologies like Digital Twins and AR/VR, and handle increasing amounts of real-time data. This ensures that the system remains relevant and effective for long-term use in the ever-evolving construction industry.

### **OUTCOMES**

#### **1. Improved Project Transparency and Real-Time Insights**

The dashboard provides real-time visibility into every aspect of the construction project, including progress tracking, worker activities, resource allocation, and budget updates. This eliminates manual reporting and allows stakeholders to make data-driven decisions instantly. With real-time dashboards and alerts, delays, safety concerns, and cost overruns can be identified early, ensuring proactive intervention.

#### **2. Enhanced Worker Safety and Risk Mitigation**

By integrating IoT sensors, AI-powered surveillance, and predictive analytics, the system significantly improves worker safety. Real-time alerts notify supervisors of potential hazards, such as poor air quality, excessive noise levels, fire risks, and worker fatigue. Additionally, helmet and safety compliance monitoring using computer vision reduces workplace accidents, ensuring adherence to safety regulations.

#### **3. Optimized Resource Utilization and Cost Reduction**

The system tracks equipment, materials, and workforce usage in real-time, preventing resource wastage and overuse. AI-driven recommendations optimize resource allocation, reducing downtime and idle periods. Automated financial tracking and anomaly detection for fraudulent transactions further ensure that projects stay within budget, avoiding unexpected cost escalations.

#### **4. Faster Decision-Making with AI-Powered Predictive Analytics**

Machine Learning models analyze historical and real-time data to predict project delays, cost overruns, and material shortages. AI-based scheduling tools suggest optimal project timelines and alternative workflows in case of disruptions. This enables faster, more accurate decision-making, ensuring projects are completed on time and within budget.

#### **5. Improved Collaboration and Communication**

The dashboard provides a centralized platform for project managers, engineers, workers, and clients to communicate and collaborate efficiently. Role-based access ensures that relevant stakeholders can view, update, and share project data securely. Integration with third-party project management tools (Jira, Trello, Microsoft Project) further streamlines workflow management and task assignments.

#### **6. Real-Time Compliance Monitoring and Regulatory Adherence**

Government regulations require strict adherence to labor laws, environmental policies, and safety protocols. The system ensures automatic compliance tracking by monitoring air pollution, noise levels, safety gear usage, and workforce working hours. Reports can be automatically generated and submitted to regulatory authorities, reducing legal risks and ensuring audit readiness.

#### **7. Automated Reporting and Documentation**

The dashboard automatically generates detailed reports on project progress, safety compliance, and financial health. Reports can be exported in PDF, Excel, or cloud storage formats for easy sharing with stakeholders. AI-based Natural Language Processing (NLP) further summarizes key insights from reports, providing a clear understanding of project performance.

#### **8. Increased Efficiency with Cloud-Based Access**

By leveraging cloud technology (AWS, Azure, or Google Cloud), project managers and stakeholders can access real-time project data from anywhere, on any device. This ensures that remote teams can monitor progress, resolve issues, and collaborate without being physically present at the site. The cloud infrastructure also ensures scalability and reliability, preventing data loss or system downtime.

#### **9. Reduction in Project Delays and Rework**

One of the major challenges in construction projects is delays due to mismanagement, miscommunication, and unforeseen risks. The system minimizes these by providing real-time alerts for project milestones, AI-driven scheduling adjustments, and automated risk assessments. By ensuring proper quality checks and AI-driven defect detection in materials and structures, rework is reduced, saving time and money.

#### **10. Sustainability and Eco-Friendly Construction Practices**

The system promotes sustainable construction by monitoring energy consumption, material waste, and environmental impact.

AI-driven insights help optimize material usage, reducing excess wastage and ensuring eco friendly construction practices. By tracking carbon emissions, water usage, and energy efficiency, the dashboard enables construction companies to adopt green building strategies, enhancing their reputation and compliance with sustainability standards.

## RESULTS AND DISCUSSIONS

### 1. Enhanced Project Visibility

The real-time dashboard significantly improved the visibility of project progress. Stakeholders can now access a unified view of the entire project, including timeline tracking, milestone completion, and resource allocation.

This resulted in quicker decision-making and timely interventions. The transparency led to greater accountability and responsiveness from all parties involved.

Discussion: Real-time visibility helps in immediate troubleshooting, especially when it comes to tracking deviations from schedules and budgets. This is crucial in the fast-paced environment of construction, where delays can cause significant cost overruns.

### 2. Improved Safety Monitoring

Integration of IoT sensors and AI-powered surveillance systems to monitor worker safety significantly reduced accident rates and improved site security.

Sensors detected unsafe environmental conditions like high noise levels, air quality issues, and fire hazards.

Discussion: The real-time alerts helped site supervisors address potential safety concerns immediately. This proactive approach is vital in preventing workplace injuries, which is a major concern in construction projects.

### 3. Optimized Resource Management

With the dashboard tracking resource utilization in real-time, the system helped ensure that labor, equipment, and materials were efficiently allocated and used.

This reduced instances of waste and underutilization.

Discussion: The optimization of resources led to significant cost savings and improved efficiency. The accurate tracking of resources allowed project managers to make more informed decisions, which directly impacted the bottom line.

### 4. Predictive Analytics for Project Management

The implementation of machine learning algorithms for predictive analytics provided early warnings regarding potential project delays, budget overruns,

and resource shortages. Discussion: By forecasting project risks and challenges, the system helped managers prepare ahead of time and mitigate those issues. This level of predictive insight is key to maintaining project timelines and budgets, especially for large-scale projects.

### 5. Real-Time Decision Making

The real-time dashboard allowed stakeholders to make decisions based on live data, significantly improving the speed and accuracy of decision-making processes.

Discussion: Traditional construction project management often relied on delayed reporting or manual updates. The real-time nature of this system ensures faster reaction times to issues and streamlines project coordination across teams.

### 6. Improved Communication and Collaboration

The system's collaborative features, including role-based access control and centralized communication, greatly improved teamwork and ensured that the right people had access to relevant data. Discussion: Improved collaboration led to fewer miscommunications and a more synchronized workflow. Stakeholders were better able to work in tandem, regardless of their physical location, which improved project coordination.

### 7. Streamlined Reporting

Automated reporting features saved a considerable amount of time by eliminating the need for manual report generation. Key insights were delivered in real-time via interactive dashboards and automated reports. Discussion: The ability to generate and share reports automatically allowed managers to stay focused on core tasks rather than administrative duties. The efficiency of these reports made it easier to track project performance and manage stakeholder expectations.

### 8. Reduced Project Delays

Through the use of AI-based scheduling, the system helped adjust project timelines dynamically, minimizing the impact of delays and ensuring timely project completion.

Discussion: Construction projects are notorious for experiencing delays. The dashboard's ability to adjust schedules and provide contingency plans resulted in reduced project delays and a more predictable timeline, ultimately improving client satisfaction.

### 9. Enhanced Budget Management

By tracking real-time expenditures and comparing them with the planned budget, the system helped identify cost discrepancies and provided insights into

budget variances. Discussion: The system's ability to track financial data continuously helped prevent cost overruns. Through detailed financial insights, it facilitated better decision-making regarding spending allocations and resource procurement.

### 10. Better Quality Control

Integration of real-time monitoring of construction materials and site inspections allowed for immediate identification of quality issues such as defects in materials or construction.

Discussion: Real-time quality control checks reduced the need for rework and the associated costs. Defect detection mechanisms helped ensure that projects met required standards from the outset, reducing waste and ensuring long-term durability.

### 11. Facilitated Regulatory Compliance

The system's compliance tracking tools helped ensure that the project adhered to local building regulations and safety standards, reducing the likelihood of fines or work stoppages. Discussion: Automated regulatory checks ensured that compliance was continuously monitored, which is a time-consuming but critical aspect of construction. Real-time monitoring of environmental parameters, safety gear usage, and working hours helped the project meet legal requirements efficiently.

### 12. Eco-Friendly Practices and Sustainability

The dashboard allowed for better tracking of energy usage, waste generation, and material recycling, contributing to more sustainable construction practices.

Discussion: As sustainability becomes an increasing priority in construction, the ability to monitor eco-friendly metrics in real-time ensures that construction projects minimize their environmental impact, while also enhancing the company's reputation in the industry.

### 13. Efficient Resource Allocation

Through the integration of data from sensor networks and project management tools, the system helped ensure that labor and equipment were allocated precisely where needed, improving overall project efficiency. Discussion: Proper resource allocation is critical in avoiding overstaffing or underutilization of resources. The real-time monitoring allowed for quick adjustments, which optimized performance and output, resulting in smoother project execution.

### 14. Enhanced Client Satisfaction

Clients benefited from real-time access to project updates, including progress tracking, budget status, and safety reports, ensuring transparency and reducing the need for frequent site visits or updates. Discussion: By keeping clients consistently updated, the system helped build trust and ensured that expectations were aligned. This transparency likely contributed to higher client satisfaction and improved customer retention.

### 15. System Scalability and Flexibility

The system's use of cloud-based infrastructure allowed for scalability, enabling the project dashboard to easily handle increased data volume and additional project sites.

Discussion: The flexibility of cloud technology made it easy to expand the dashboard to include more projects, sites, and teams, supporting long-term growth and adaptation to future requirements.

## CONCLUSION

The Real-Time Monitoring Dashboard has transformed construction management by integrating IoT, AI, and real-time analytics. It offers a centralized platform for tracking progress, safety, resources, budget, and environmental factors. Key benefits include improved decision-making, reduced delays and accidents, optimized resource use, and enhanced sustainability. With predictive insights and cloud-based scalability, the system ensures efficient, safe, and eco-friendly construction across multiple sites.

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