# FINAL PRESENTATION

Artificial Intelligence Applications in Civil Engineering:

A Comprehensive Analysis of Current Trends and Technologies

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# 1. INTRODUCTION

## 1.1 Background

The construction industry is undergoing a significant transformation driven by the integration of Artificial Intelligence (AI) and Machine Learning (ML) technologies. These technologies are revolutionizing traditional practices in civil engineering, from design optimization to construction site safety monitoring and predictive maintenance. This research presents a comprehensive analysis of how AI is being applied across various domains of civil engineering, based on an extensive review of news articles and academic publications.

This study analyzed a total of **899** articles from various sources, of which **442** (49.2%) were identified as directly relevant to AI applications in civil engineering. The remaining **457** articles were filtered out as they discussed general construction topics without specific AI/ML applications.

## 1.2 Research Objectives

The primary objectives of this research are:

• To identify and categorize AI applications in civil engineering

• To analyze temporal trends in AI adoption across different construction domains

• To determine which civil engineering areas are most impacted by AI technologies

• To identify the most prevalent AI techniques being utilized in the industry

• To provide insights into the future direction of AI in construction

# 2. METHODOLOGY

## 2.1 Data Collection

Data was collected from multiple sources using a hybrid approach combining automated collection methods:

| Source Type | Description | Count |
|---|---|---|
| RSS | News articles and academic papers | 253 |
| SCHOLAR | News articles and academic papers | 183 |
| API | News articles and academic papers | 6 |

## 2.2 Data Processing Pipeline

The data processing pipeline consisted of the following stages:

• **RSS Feed Collection:** Automated collection from 16+ industry RSS feeds including Google News

• **API Integration:** News collected from GNews API, NewsAPI, and The Guardian API

• **Academic Sources:** Google Scholar papers collected via SerpAPI

• **Deduplication:** URL-based and title-based deduplication to ensure unique articles

• **Data Validation:** Quality checks for missing fields and data integrity

## 2.3 LLM Classification

Each article was processed using Google's Gemini 2.0 Flash large language model for intelligent classification. The LLM performed the following tasks:

• **Relevance Filtering:** Determining if the article discusses actual AI/ML applications

• **Category Classification:** Assigning primary application category (Safety, BIM, etc.)

• **CE Area Identification:** Identifying the civil engineering domain

• **AI Technique Extraction:** Determining the AI/ML technique discussed

• **Keyword Generation:** Extracting relevant keywords for analysis

• **Summary Generation:** Creating concise article summaries

# 3. ANALYSIS RESULTS

## 3.1 Category Distribution Analysis

The analysis of category distribution reveals the primary areas where AI is being applied in civil engineering. The following chart illustrates the distribution of articles across different application categories:

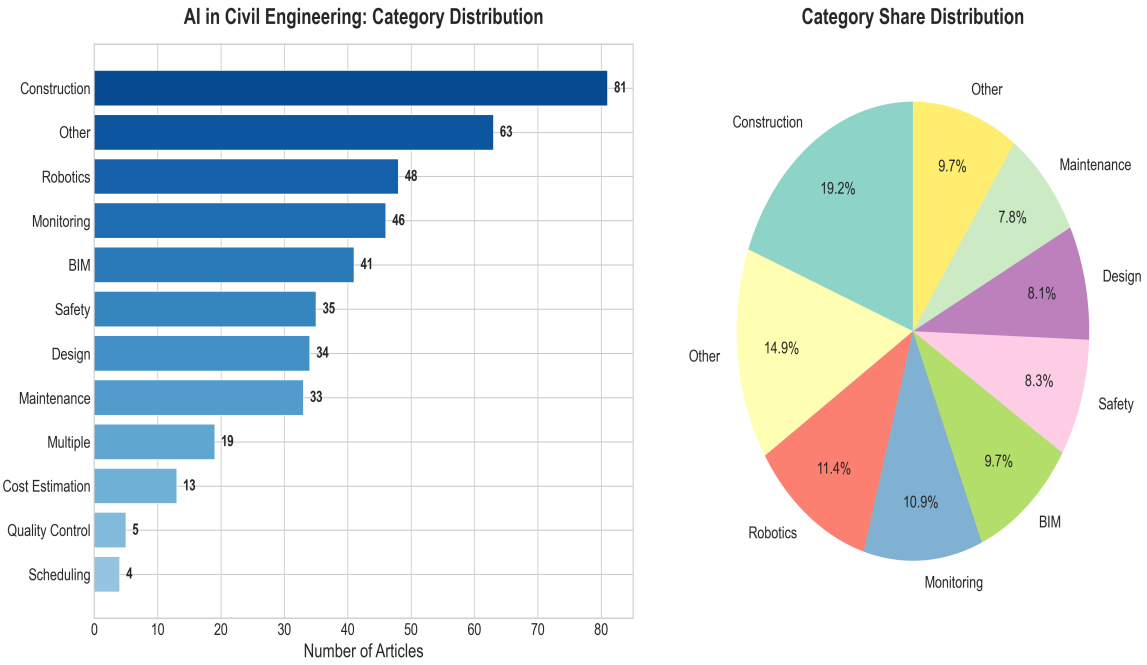


*Figure 1: Distribution of AI applications by category*

The most prominent category is **Construction** with 81 articles, followed by Other (63 articles) and Robotics (48 articles).

## 3.2 Time-based Trend Analysis

Temporal analysis provides insights into how AI adoption in civil engineering has evolved over time. The following visualization shows publication trends:

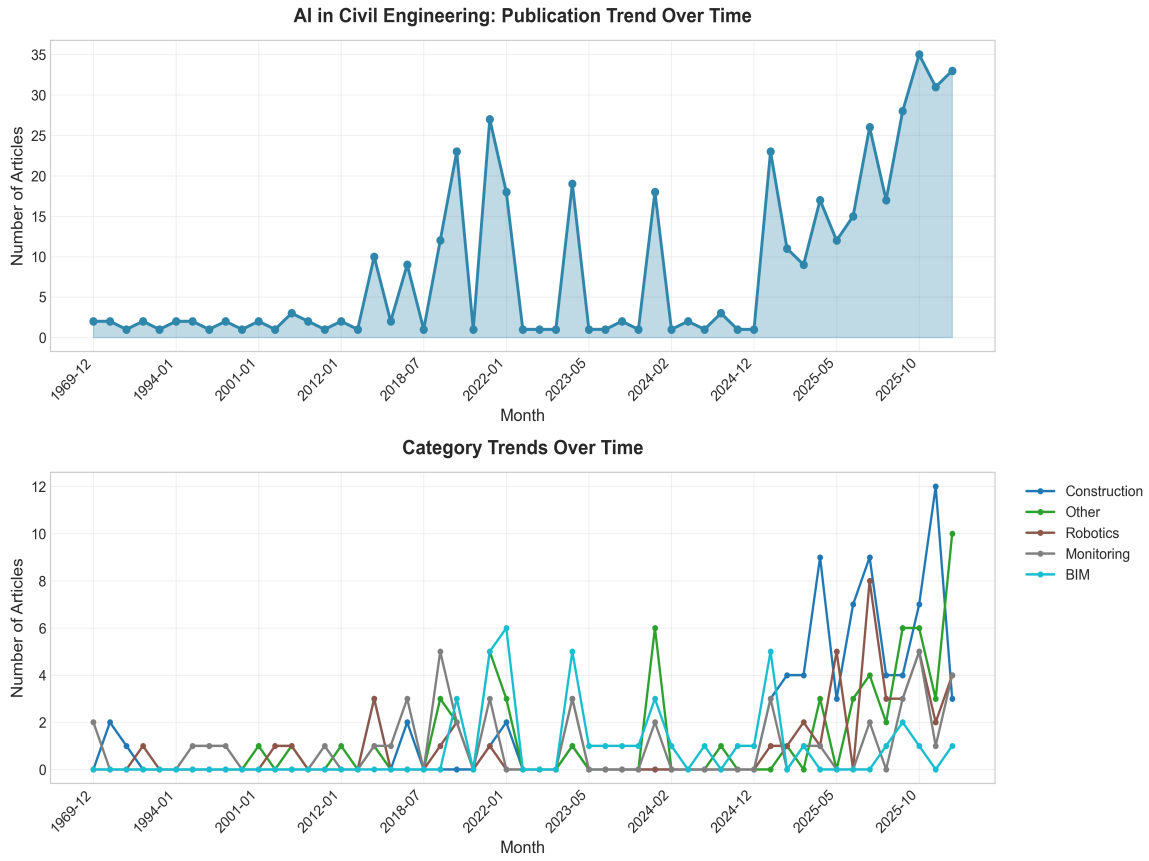


*Figure 2: Publication trends over time showing overall and category-specific patterns*

## 3.3 Application Stage Analysis

This analysis examines at which stage of the construction project lifecycle AI technologies are being applied:

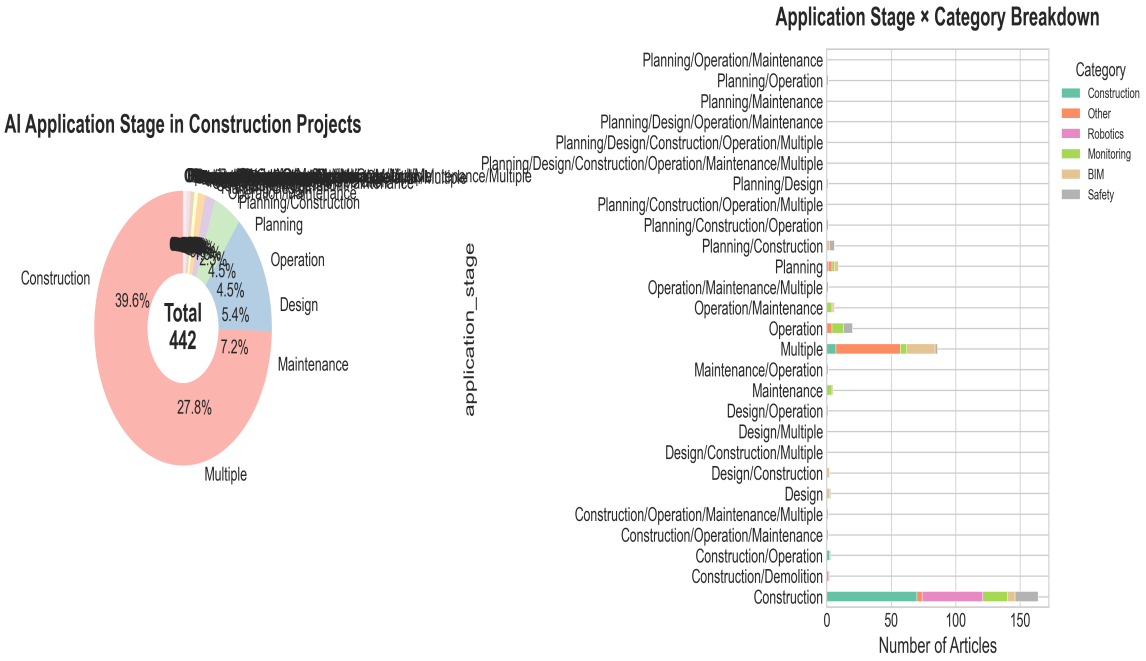


*Figure 3: AI applications across project lifecycle stages*

## 3.4 Keyword Analysis

Keyword analysis reveals the most frequently discussed terms and concepts in AI-related civil engineering literature:

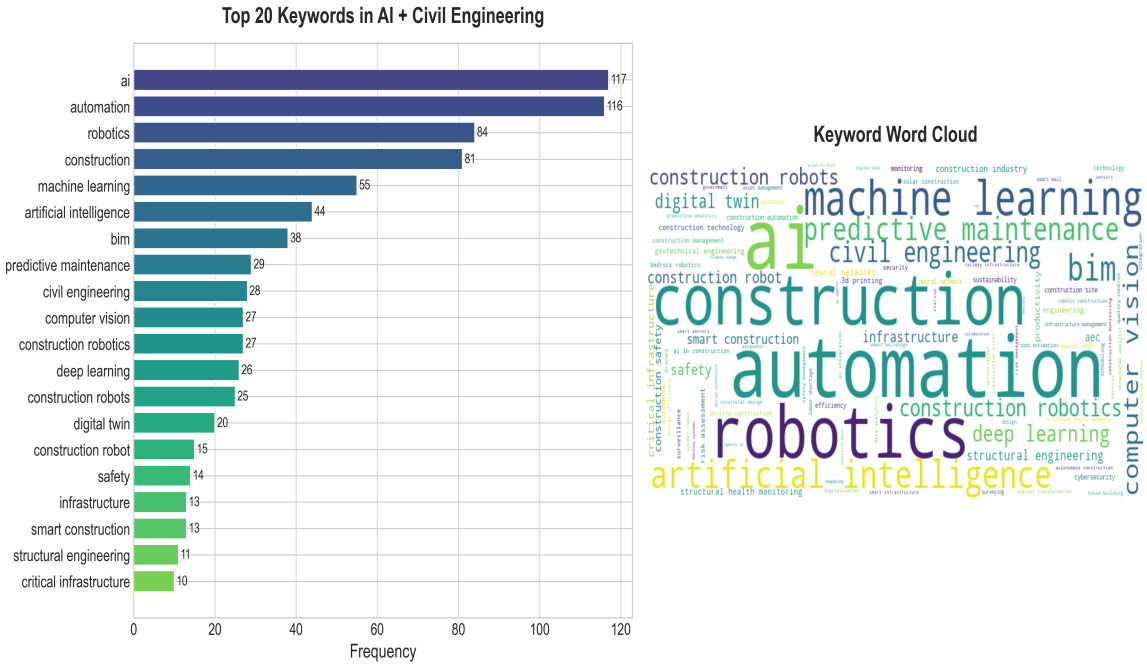


*Figure 4: Top keywords and word cloud visualization*

## 3.5 Source Analysis

Analysis of data sources helps understand the origin and reliability of the collected information:

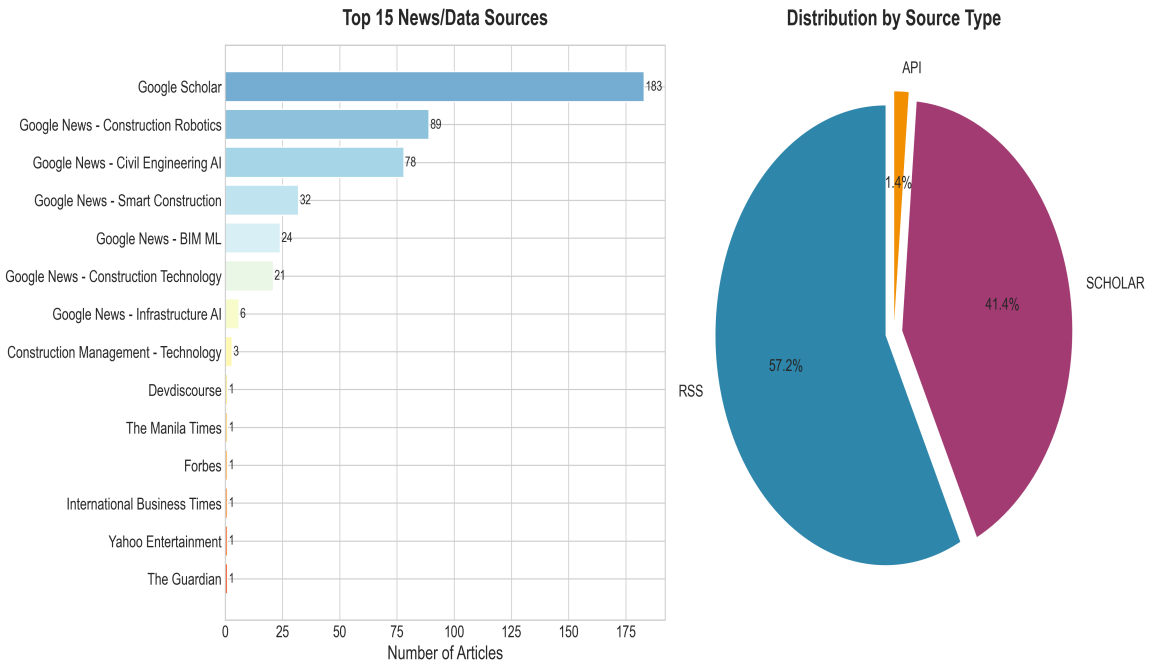


*Figure 5: Distribution of articles by source*

## 3.6 Time-Topic Relationship

The heatmap visualization shows how different topics have evolved over time, revealing emerging trends and shifting focus areas:

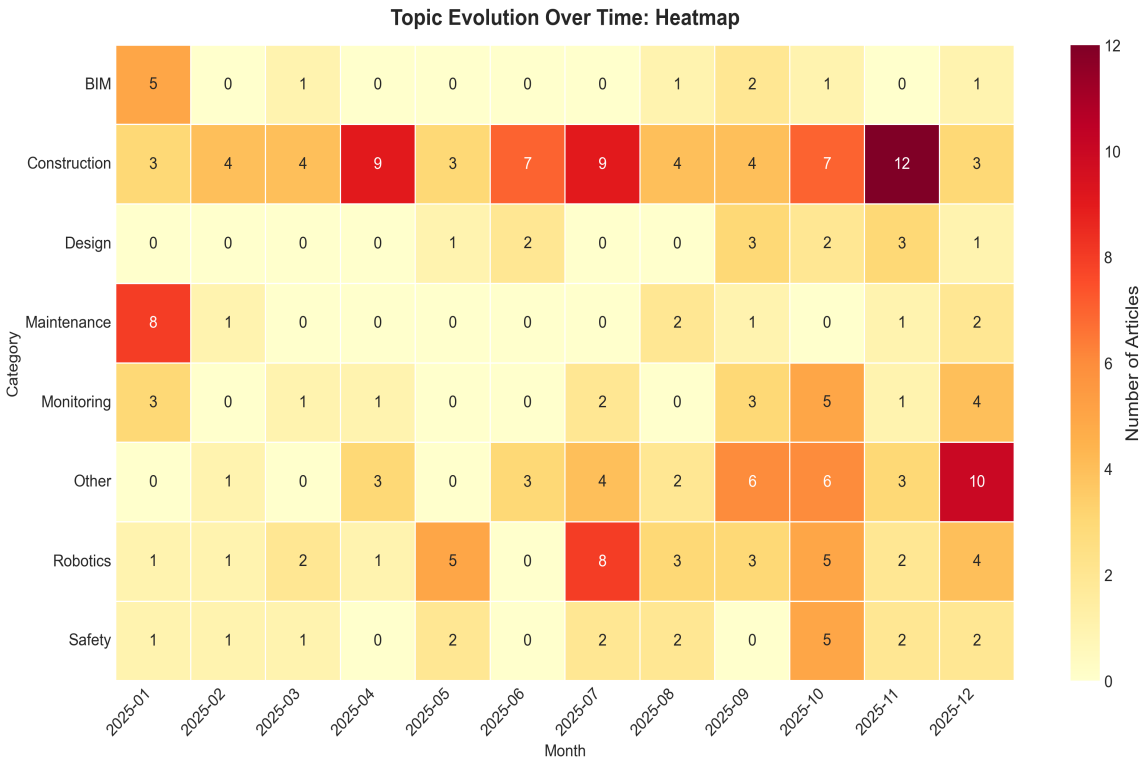


*Figure 6: Heatmap showing topic evolution over time*

## 3.7 Civil Engineering Areas Analysis

This analysis examines which civil engineering disciplines are most impacted by AI technologies:

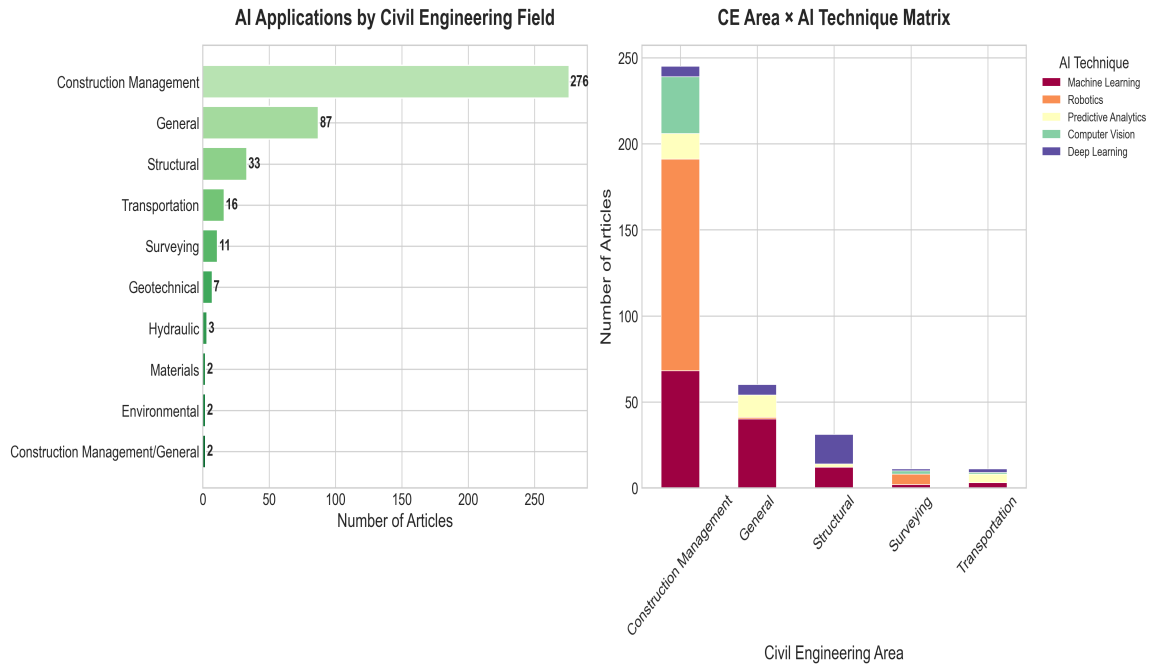


*Figure 7: AI applications across civil engineering disciplines*

**Construction Management** emerges as the leading area with 276 articles, indicating significant AI adoption in project management and field operations.

## 3.8 AI Techniques Distribution

Analysis of AI techniques reveals which machine learning and artificial intelligence methods are most commonly applied in civil engineering:

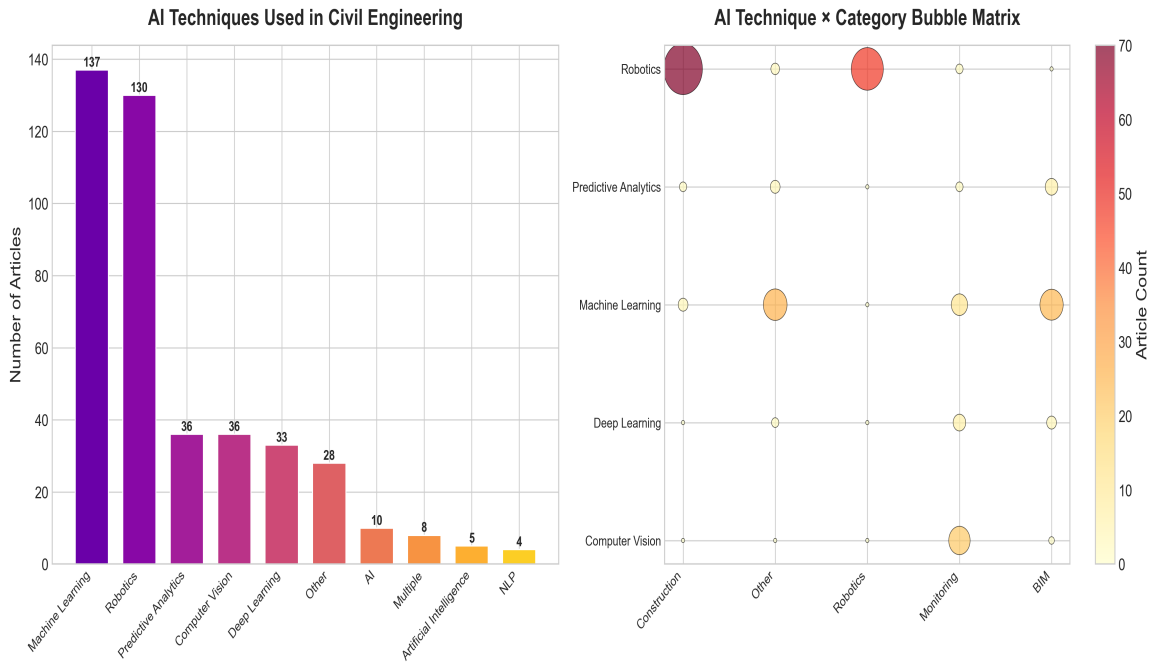


*Figure 8: Distribution of AI techniques used in civil engineering*

**Machine Learning** is the most prevalent technique with 137 applications, followed by Robotics (130 articles).

# 4. KEY FINDINGS

Based on the comprehensive analysis of 899 articles, the following key findings have been identified:

• **High AI Relevance:** 49.2% of analyzed articles were directly relevant to AI applications in civil engineering, indicating significant industry interest.

• **Dominant Application Area:** Construction emerged as the primary category, suggesting strong focus on construction operations and automation.

• **Leading AI Technique:** Machine Learning is the most widely applied AI method, followed by robotics and automation solutions.

• **Construction Management Focus:** Construction Management represents the primary civil engineering domain benefiting from AI integration.

• **Safety Applications:** AI-powered safety monitoring and hazard detection systems are gaining significant attention in the industry.

• **BIM Integration:** Building Information Modeling enhanced with AI capabilities represents a growing trend in design and planning phases.

• **Predictive Analytics:** Predictive maintenance and cost estimation using ML models are becoming increasingly common.

• **Computer Vision:** Image and video analysis for quality control and site monitoring is a rapidly advancing application area.

# 5. CONCLUSION

This comprehensive analysis of 899 articles reveals that Artificial Intelligence is rapidly transforming the civil engineering and construction industry. With 442 (49.2%) articles directly addressing AI/ML applications, it is evident that the industry is actively embracing these technologies.

The research demonstrates that AI applications span across all phases of the construction project lifecycle, from planning and design to construction operations and maintenance. Machine Learning and Robotics emerge as the dominant techniques, while Construction Management benefits most from these technological advances.

Looking forward, the trends indicate continued growth in AI adoption, particularly in areas such as safety monitoring, predictive maintenance, and automated quality control. The integration of Computer Vision and Deep Learning technologies is expected to further revolutionize on-site operations and project management practices.

## Future Research Directions

Based on the findings, the following areas merit further investigation:

• Integration of generative AI in structural design optimization

• Development of comprehensive AI frameworks for construction safety

• Advancement of autonomous construction equipment and robotics

• AI-driven sustainability analysis and environmental impact assessment

• Real-time decision support systems for project management

# REFERENCES

Data sources and APIs used in this research:

[1] Google News RSS Feeds - news.google.com

[2] GNews API - gnews.io

[3] NewsAPI - newsapi.org

[4] The Guardian API - open-platform.theguardian.com

[5] Google Scholar via SerpAPI - serpapi.com

[6] Google Gemini 2.0 Flash - ai.google.dev