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# IOT for Construction Equipment Management and Maintenance

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## Abstract

The equipment management and maintenance processes in the construction sector are changing due to new technologies like the Internet of Things (IoT). IoT technology enables the real-time capture of data from construction equipment, which can then be evaluated to maximize equipment lifespan, decrease downtime, and improve efficiency. This article seeks to provide an overview of current IoT trends for managing and maintaining construction equipment, as well as the difficulties and possibilities that this technology presents. To use IoT technology, there are a number of obstacles to overcome, such as connectivity issues and the requirement for specific training and understanding. However, it is anticipated that IoT use in the construction industry will increase over time as businesses look to increase productivity, cut costs, and improve sustainability and safety standards. The potential advantages of IoT for managing and maintaining construction equipment are discussed in this study, along with the difficulties that must be solved to fully achieve these advantages.

**Keywords:** Equipment management; internet of things; predictive maintenance; drones; data analysis; machine learning; construction sector; efficiency improvement; sustainability

## Introduction

IoT technology has become increasingly important in the construction industry, particularly in equipment management and maintenance [1]. It provides real-time data on equipment usage and condition, leading to more efficient management and predictive maintenance. Telematics was one of the first examples of IoT in construction equipment, allowing companies to monitor equipment usage, location, and maintenance requirements in real-time[2]. Today, IoT is used to monitor equipment performance, forecast maintenance needs, and enhance construction site safety and efficiency [3]. AI and machine learning (ML) technologies, drones, smart buildings, and digital twins can analyse data generated by IoT devices in real-time, allowing for more accurate predictions of equipment failure and maintenance requirements.

The design of the project divides the overall system architecture into three levels: interface layer, functional layer, and data exchange layer[4]. Four components make up the technique for studying IoT in construction equipment management and maintenance: an analytical analysis of the literature on IoT in construction equipment management and maintenance, a questionnaire must be created and enhanced to collect information from construction companies that have integrated IoT technology into their procedures, and statistical techniques must be used to assess the data gathered [5].

## Literature Review

The predictive maintenance (PM) issue of a single equipment system is covered in this study. Researched by Xiao Wang et al. [6] It is presumable that as the equipment functions, its quality states may deteriorate, leading to a range of yield levels that are represented as system observation states. We characterize equipment deterioration as a discrete-state and continuous-time semi-Markov decision process (SMDP) problem, and we use a strategy-based approach to solve the SMDP problem in a reinforcement learning (RL) framework. The objective is to produce the best maintenance strategy for a set of observation states while maximizing the system average reward rate (SARR).

  

The issues with low utilization, poor interoperability, and severe knowledge loss have begun to surface. Researched by Guozhen Zhang et al. [7] For large-scale coal mine equipment maintenance resources, it is vital to investigate novel knowledge system building and knowledge management application technology. A knowledge graph uses a graph model to technically represent how objects relate to one another in the real world. Based on the BERT-BiLSTM-CRF model, the entity identification of coal mine equipment maintenance is finished.

The transport component of the maintenance process can be separated. Researched by Jonghui Han et al. [8] From the perspective of module transfer, this research suggests a paradigm for maintenance automation for automated pyro processing machinery. Because there isn't enough room in the cell and remote handling tools aren't always functional, replacing breakdown modules is preferred to in-situ repair for the majority of remote maintenance tasks on equipment in hot cells.

The CAD-aided intelligent operation and maintenance of power system equipment (CAD-IOMPSE) incorporates the data gathered by the cluster intelligent and complex optimization of the power system equipment and the cluster intelligent and complex optimization algorithms. Researched by Yinguan Song et al. [9] The findings of example analysis demonstrate that the method used in this work outperforms the conventional named entity recognition algorithms, BiLSTM SoftMax and Seq2Seq-Attention model, in terms of accuracy, recall, and F1 value.

Medical professionals have not set up a comparable quality management system for the process of maintaining and maintaining large-scale medical equipment, neglecting daily maintenance and maintenance, leading to numerous hidden risks of medical mishaps. Researched by Jiansheng Li et al. [10] Based on information fusion technology, medical equipment maintenance and quality control are effective.

**Methodology**

The study examined the implementation of IoT gadgets in buildings for monitoring and managing various systems, such as energy efficiency, occupant comfort, and building security [11]. Throughout the research, obstacles including connectivity issues and the need for specific training and understanding of IoT technology were considered. The methodology also involved analysing the potential advantages of IoT for managing and maintaining construction equipment, while addressing the difficulties that need to be resolved for the full realization of these benefits [12]. Data collection, analysis techniques, and relevant equations were employed in accordance with the research objectives and scope of the study.

$$SS = \frac{Z^2 \times P(1-P)}{C^2}$$

where:

SS = Sample Size;

Z = Z value (1.96 for 95 per cent confidence level) l;

P = percentage picking a choice, expressed as a decimal (0.5 used for sample size needed); and

C = margin of error (9 per cent), maximum error of estimation which can be 9 or 8 per cent.

$$SS = \frac{1.96^2 \times 0.5(1-0.5)}{0.09^2} = 118.57 \cong \approx$$

119 (as the minimum sample size)

This project divides the overall system architecture into three levels: interface layer, functional layer, and data exchange layer. The interface layer is the common system operating interface, while the functional layer is used to receive and implement requests for various functions [13]. The interface layer is used to ensure the functionality of the functions while making full use of the interface space, consistent background color, neat typography, different font sizes, and prominent functional modules.

  

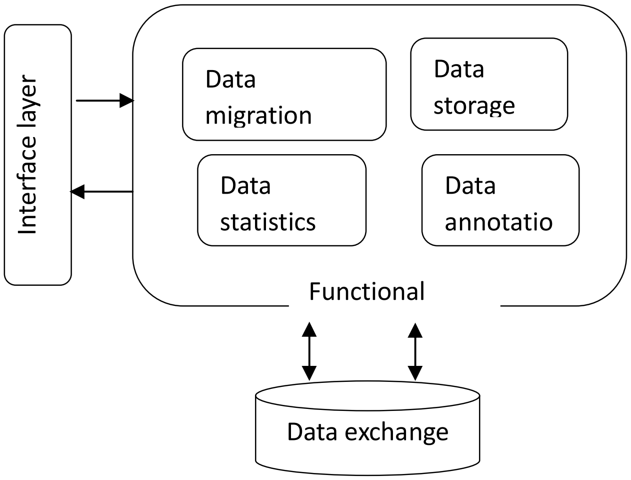


**Figure 1**: Schematic diagram of the entire system architecture

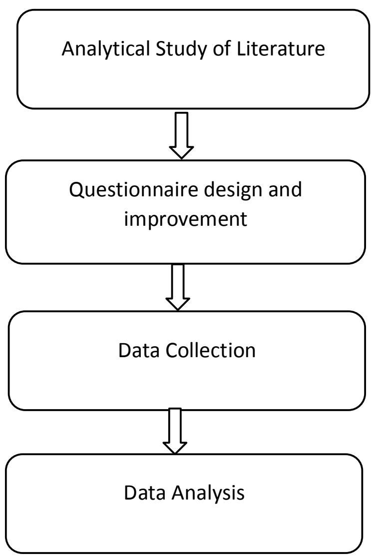


**Figure 2**: Study Flowchart

The technique for studying IoT in construction equipment management and maintenance involves four components: an analytical analysis of the literature, a questionnaire to collect information, and statistical techniques to assess the data gathered [14]. The first step is to perform an analytical analysis of the literature, which will lay a theoretical foundation for the subject and show any gaps in the body of knowledge. The second step is to gather information from construction companies that have integrated IoT technology into their procedures for managing and maintaining their equipment. The third step is to gather information from industry associations and businesses, and the questionnaire will be given out. Finally, statistical techniques like regression analysis, descriptive statistics, and hypothesis testing must be used to assess the data gathered [15]. This technique offers a structured method for investigating IoT in the construction sector and may be used to find potential for innovation and improvement.

## Result and Analysis

The main concern of this part was to select the appropriate participants to answer the questions by investigating their demographic profile. The businesses the participants were employed by mostly fall into two categories: privately owned businesses and publicly traded businesses run by officials. Private enterprises make up the largest percentage, with 72% of the total and 23% for government-owned businesses. The distribution of participant qualifications is shown in Figure 6, with 71% of participants having bachelor's degrees, 21% having diplomas and a small number having master's and PhD degrees. The number of years respondents worked in the construction industry is shown in Figure 7, with most of the participants having less than ten years of experience. The level of awareness and possibility of IOT deployment in the construction business is shown in Figure 6, with 63% of participants understanding IOT technology and idea, 57% being aware of IOT, and 31% intending to incorporate IOT into project executions, while only 28% agreed to set aside additional funds for IOT introduction to their organizations.

  

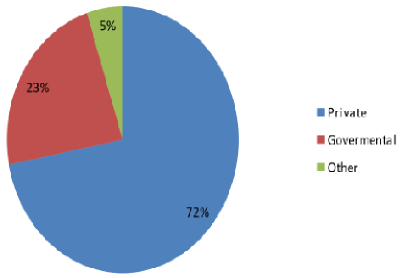


**Figure 3:** Categories of company

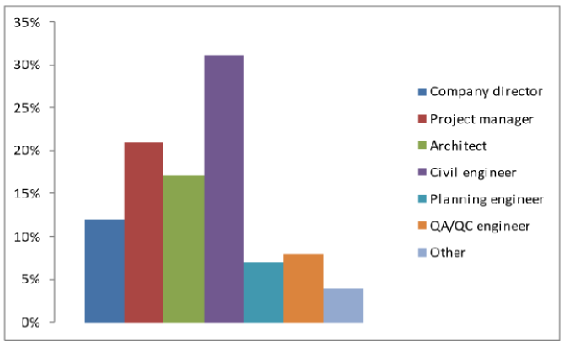


**Figure 4**: Designation of participants

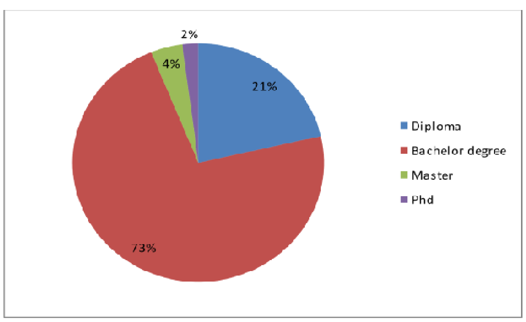


**Figure 5:** Qualification of participants

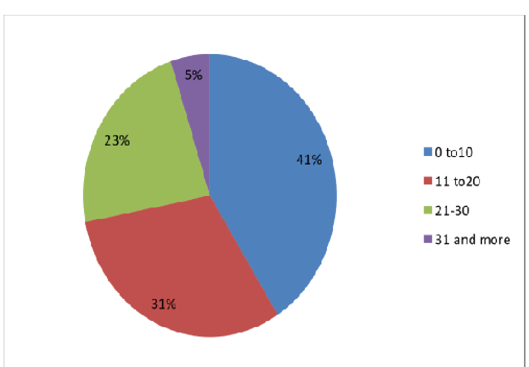


**Figure 6:** Years of experience in construction

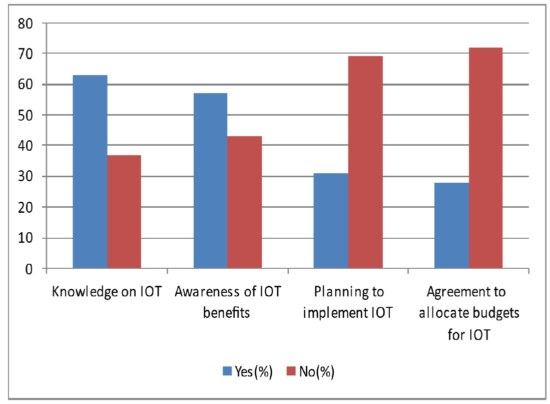


**Figure 7:** Awareness of IOT application in construction projects

## Conclusion

This study examined the utilization of IoT in the management and repair of construction equipment. A questionnaire was administered to participants in the construction industry, focusing on their demographics, company types, job titles, education, and experience. The findings indicated a growing interest in utilizing IoT for managing and maintaining construction equipment, with many participants expressing plans to incorporate it into their project execution. However, a minority of participants agreed to allocate additional resources for IoT adoption. To fully leverage IoT capabilities, product development focuses on hardware and software components, as well as AI and ML algorithms. Overall, the construction industry stands to gain numerous benefits from embracing IoT in equipment management and maintenance, including enhanced productivity, cost reduction, improved safety and security, and sustainable business practices.

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