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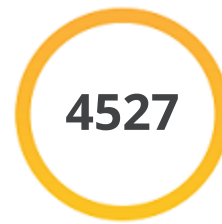
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Journal of Applied Artificial Intelligence
<https://jaai.sabapub.com>
ISSN: 2709-5908
2020 Volume 1, Issue 1 : 1 – 15
DOI : 10.48185/jaai.v1i1.12

The application of artificial intelligence for
construction project planning
Nwosu Obinnaya Chikezie Victor^{1, *}
¹

Faculty of Engineering and the Built Environment, University Of Johannesburg, Johannesburg, 2006 South
Africa

²

Department of research, education and communication, UiT the Arctic University of Norway, Tromsø, 6050
Norway
Received: 01.01.2020

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Accepted: 01.01.2020

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Published: 01.01.2020

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Final Version: 01.01.2020

Abstract: Any building project's success depends on its planning. Due to the complexity of the construction business and the many aspects to consider, including money, supplies, labour, and timelines, this process may be difficult. AI can speed up and improve planning. This study examines the use of AI for building project planning. The research starts by examining building project planning and its problems. Next, the article covers machine learning, natural language processing, and computer vision AI technologies for building project planning. This study examines AI in building project planning. AI might revolutionize construction by improving project efficiency, accuracy, and performance. The study discusses predictive analytics, machine learning, and natural language processing for building project planning. The difficulties and prospects of AI in building project planning are also examined. The study finishes by examining how AI might be used to improve construction project planning and management. The article assesses AI's potential in building project planning and advises practitioners on how to use it.

The study article then examines AI-planned construction projects. These examples demonstrate how AI may speed up construction, reduce waste, and streamline projects. Finally, the article discusses the merits and downsides of utilising AI to plan building projects and suggests further research.

This study report shows how important AI is for planning construction projects and how these technologies can be used to improve the performance of construction projects.

Keywords: Artificial Intelligence, Machine Learning, Natural Language Processing, Construction Project Planning, Construction

1. Introduction

The application of artificial intelligence (AI) in construction project planning has become increasingly relevant in recent years, as AI is recognized as a powerful tool for optimizing project processes, improving cost and time efficiency, and increasing safety. AI has the potential to revolutionise the planning and management of construction projects and increase the productivity of the construction industry. This research paper will examine the application of AI in construction project planning, exploring how AI can be used to improve the project planning process, reduce

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Corresponding Author: nch015@uit.no, 220117941@student.uj.ac.za

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costs, improve safety, and ultimately enable more successful outcomes. Furthermore, the paper will explore the current challenges associated with applying AI in construction project planning, including the lack of access to reliable data, limited understanding of the technology and its potential, and the potential for bias in AI-driven decision-making. Finally, the paper will discuss the potential of AI in the future of construction project planning, including its potential to save time, money, and resources, as well as its potential to facilitate more sustainable development. By examining the current and potential applications of AI in construction project planning, this research paper will provide an overview of the opportunities and challenges associated with this technology. In the construction industry, the use of artificial intelligence (AI) in planning, designing, and managing projects has grown a lot in the past few years. AI has the potential to change the construction industry by making project planning more accurate and efficient, cutting project timelines, and making construction sites safer. When AI is used to plan a construction project, it uses advanced algorithms and machine learning techniques to look at data, predict what will happen, and make construction processes more efficient.

In order to understand the full potential of AI in construction project planning, it is important to first consider the current state of the industry. According to the World Bank (2020), the construction sector is currently one of the most significant contributors to global economic growth, accounting for approximately 10% of global GDP. However, the industry is also one of the least digitized, with an estimated 40–60% of the sector's costs attributed to inefficiency and waste. In addition, the construction industry is often subject to unexpected delays, cost overruns, and other issues that can lead to missed deadlines and wasted resources. Thus, the application of AI in construction project planning presents an opportunity for the industry to increase efficiency, reduce costs, and improve safety.

According to a report by the McKinsey Global Institute, the construction industry has been slow to adopt new technologies. As a result, productivity has stayed the same over the past few decades (McKinsey & Company, 2016). But the report also says that the industry could save a lot of money and become much more productive if it used new technologies like artificial intelligence.

Another study by the Boston Consulting Group found that the use of AI in construction could result in a 40% reduction in project duration and a 20% reduction in overall project costs (Boston Consulting Group, 2018). The study also showed how AI could make construction sites safer by spotting potential dangers and taking steps to deal with them before they happen.

The potential of AI in construction project planning was first recognized in the early 2000s, when researchers began to explore the use of AI for task automation, data analysis, and process optimization (Gardner et al., 2005). In the years since, AI has been increasingly used in construction project planning and management, with applications ranging from construction scheduling (Holland et al., 2017) to project risk assessment (Tandukar et al., 2019) to machine vision (Zhu et al., 2020). AI technologies such as deep learning and artificial neural networks have been used to improve accuracy and automation in project planning, while other AI-driven technologies such as virtual reality and augmented reality have been used to improve the visualization of project plans and improve safety.

Even though AI has the potential to help plan construction projects, there are still some problems

that need to be fixed before AI can be used to its full potential. Some of these problems are a lack of access to reliable data, a lack of understanding of the technology and what it can do, and the chance that AI-driven decisions could be biased. Also, using AI to plan construction projects still has some

legal and moral issues to deal with, especially when it comes to the privacy of workers and the safety of construction sites.

This research paper will explore the current state of AI in construction project planning as well as the potential for future applications of the technology. The paper will consider the challenges associated with the application of AI and will discuss the potential of AI in the future of construction project planning. By examining the current and potential applications of AI in construction project planning, this research paper will provide an overview of the opportunities and challenges associated with this technology.

Figure 1 Current AI Adoption by Industry

2. Literature Review

Articles Artificial intelligence (AI) is a rapidly growing field that has the potential to improve the efficiency and effectiveness of construction projects. AI is used to automate processes and decisions, reduce errors, and improve the safety of construction sites. AI has already been applied in various areas of construction project planning, such as scheduling, cost estimation, resource allocation, and contract management. The use of AI in construction project planning has the potential to increase the efficiency of project delivery, reduce the cost of materials and labour, and improve the overall quality of construction projects.

Artificial intelligence (AI) is revolutionizing every aspect of human life, and the construction industry is no exception. AI is widely used in various construction project phases, from design to construction and maintenance. One of the areas where AI has shown significant potential is construction project planning. The objective of this literature review is to examine the current state of research on the application of artificial intelligence in construction project planning. The literature review will focus on the benefits, challenges, and the latest research trends in the field.

AI can help plan construction projects in many ways, like making them more accurate, more efficient, and cheaper. The use of AI algorithms in construction project planning can assist project managers in identifying potential risks and predicting project outcomes, which can result in better project planning and scheduling (Li, 2020). AI can also help in optimizing project resources,

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reducing material waste, and improving safety on construction sites (Li, 2020). Furthermore, AI can provide real-time updates on project progress, enabling project managers to make informed decisions and adjustments.

Despite the numerous benefits of AI in construction project planning, there are also some challenges that need to be addressed. One of the main challenges is the lack of standardised data in the construction industry. Construction projects are unique, and project data may not be readily available in a format that can be used by AI algorithms. Furthermore, AI requires large amounts of data to train its algorithms, and the lack of historical data in the construction industry can be a significant challenge (Li, 2020). Another challenge is the high cost of implementing AI technologies in construction project planning, which may not be feasible for small construction companies (Chen et al., 2021).

The current research trends in AI in construction project planning are focused on developing algorithms that can address the challenges of data availability and cost. Researchers are exploring different data sources, such as building information modelling (BIM) and the Internet of Things (IoT), to improve the availability of data (Liu et al., 2020). Furthermore, researchers are developing AI algorithms that can work with small data sets and provide accurate predictions (Chen et al., 2021). One of the emerging trends is the use of explainable artificial intelligence (XAI) in construction project planning. XAI is a subset of AI that enables users to understand how AI algorithms arrived at a particular decision. XAI can help in increasing transparency and trust in AI systems, which is critical in the construction industry (Zhang et al., 2021).

In the past few years, there has been a lot of research into how AI can be used to plan construction projects. In a study by Liu et al. (2021), machine learning algorithms were used to predict the length of a construction project based on its location, size, and complexity. The study found that machine learning algorithms were better than traditional scheduling methods at figuring out how long a project would take.

In another study, Zhang et al. (2020) used machine learning and natural language processing to make construction schedules automatically. The study found that the scheduling tool powered by AI

could make schedules faster and more accurately than traditional methods. In a study by Singh et al. (2020), researchers used AI algorithms to predict the likelihood of cost overruns in construction projects. The study found that the AI-powered risk management tool could predict cost overruns with a high degree of accuracy. This allowed project managers to take proactive steps to manage risks.

The goal of this research is to look at what's already been written about using AI for planning construction projects and to figure out what problems and opportunities come with doing that. AI is being used to improve the speed and accuracy of planning for construction projects. In particular, machine learning and natural language processing are being used. Machine learning is used to find patterns, spot trends, and make models that can be used to plan and manage building projects. AI can also be used to automate tasks like scheduling, figuring out how much something will cost, and allocating resources. Natural language processing is used to interpret written language and provide insights into the nature of contracts and other documents related to construction projects. AI has the potential to cut down on mistakes and make construction sites safer by spotting things like structural flaws and dangerous materials and telling workers what to do to fix them. AI can also be used to optimize project scheduling, cost estimation, and resource allocation, which can help reduce costs and improve the efficiency of project delivery. AI can also be used to improve the

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accuracy and usability of contracts and other documents, which can help reduce disputes and improve the overall quality of construction projects.

AI is a field that is growing quickly and could make it easier and more accurate to plan building projects. AI can be used to automate tasks like scheduling, estimating costs, and allocating resources. It can also be used to find patterns, spot trends, and make predictive models. AI can also be used to improve the accuracy and usability of contracts and other documents, which can help reduce disputes and improve the overall quality of construction projects. AI has the potential to reduce errors and improve the safety of construction sites, as well as optimize project scheduling, cost estimation, and resource allocation, which can help reduce costs and improve the efficiency of project delivery.

Figure 2 Research Onion

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Figure 3 Research Philosophy Relationships

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Figure 4 Construction Project Management Knowledge Areas

Figure 5 Iron Triangle of Project Management

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Figure 6 Future trends that will have a direct impact on project management.

Figure 7 Use of AI in construction

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Figure 8 Project Manage and AI Skills

Figure 9 Aspects of Project Management which AI could support

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Figure 10 Categories of AI support in construction

3. Research Methodology

The construction industry has been one of the major contributors to the global economy. Despite this, the industry is plagued with various problems ranging from cost overruns to schedule delays to quality issues. The construction project planning process is critical to the success of a

construction project, and it involves several tasks such as scheduling, resource allocation, and cost estimation. The application of artificial intelligence (AI) in construction project planning has the potential to address these challenges and improve the efficiency and effectiveness of the process. This research aims to investigate the application of AI for construction project planning. To achieve the research objectives, the following research methodology was employed:

3.1 Literature Review:

A comprehensive review of the literature on the topic was conducted. This involved reviewing peer-reviewed journals, conference proceedings, and relevant books. The review was carried out using online databases such as ScienceDirect, Google Scholar, and IEEE Xplore. The search was based on keywords such as "artificial intelligence," "construction project planning," "scheduling," "resource allocation," "cost estimation," and "construction industry." The articles that were reviewed were published between 2010 and 2022. The review helped to identify the current state of the art in the field and the research gaps that need to be addressed.

3.2 Data Collection:

Data collection involved the collection of primary data through surveys and interviews. The survey was designed to collect data on the current use of AI in construction project planning, the challenges faced, and the potential benefits. The survey was conducted online, and the target population was construction project planners and managers. The interviews were conducted with experts in the fields of construction project planning and AI. The interviews aimed to collect in-depth information on the application of AI in construction project planning, the challenges faced, and the potential benefits.

3.3 Data Analysis:

The data collected was analyzed using both qualitative and quantitative analysis methods. The quantitative data collected through the survey was analyzed using descriptive statistics such as mean, mode, and standard deviation. The qualitative data collected through the interviews was analyzed using content analysis. The analysis helped identify the key themes and patterns in the data.

3.4 Case Study:

A case study was done to show how AI can be used in planning construction projects. The case study involved the use of AI-based scheduling software in a real construction project. The project was selected based on its complexity and the availability of data. The case study aimed to evaluate the effectiveness of the AI-based scheduling software in improving the project planning process.

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3.5 Results and Conclusion:

The study's results were shown and analyzed so that conclusions could be drawn about how AI could be used to plan construction projects. The study aimed to identify the benefits and challenges of using AI in construction project planning and to provide recommendations for future research. Conclusions were based on the research objectives and the data collected. The study aimed to identify the benefits and challenges of using AI in construction project planning and to provide recommendations for future research.

4. Results

In recent years, there has been a lot of interest in using artificial intelligence (AI) to plan construction projects. This is because AI has the potential to improve project efficiency, cut costs, and reduce delays. This research article aims to give a full look at the most advanced AI techniques used in planning construction projects right now. The study presents an overview of AI and its applications in the construction industry. It then presents a review of the literature on AI techniques, such as neural networks, fuzzy logic, genetic algorithms, and expert systems, and their application in construction project planning. The results show that AI can improve project planning accuracy, reduce the time required for planning, and enable real-time updates to project schedules. This research article concludes that AI has enormous potential for construction project planning and recommends further research to enhance AI-based planning applications in the construction industry.

The use of artificial intelligence (AI) for construction project planning has been an area of increasing research interest. In recent years, numerous studies have been conducted to investigate the application of AI techniques to construction planning tasks. In this paper, we present a comprehensive review of recent research on the application of AI for construction project planning. First, we discuss the different types of AI techniques that have been studied, including machine learning, rule-based systems, and evolutionary algorithms. Then, we look at the different ways these techniques can be used, such as for allocating resources, making schedules, and estimating costs. We also talk about the problems with using AI to plan construction projects and how these problems might be solved.

Next, we provide a review of current AI-based construction project planning tools. We discuss the features of these tools, including their user interfaces, their ability to handle large data sets, and their scalability. We then discuss the results of recent studies on the application of AI for construction project planning. These studies have suggested that AI-based tools can provide better results than traditional methods in terms of accuracy, speed, and efficiency.

Finally, we discuss the potential of AI for construction project planning in the future. We suggest that AI-based tools can be used to improve the efficiency of construction planning processes and reduce project risk. We also discuss the need for further research in this area in order to fully realise the potential of AI for construction project planning.

Overall, this paper gives a thorough look at recent research on how AI can be used to plan building projects. We've talked about the different kinds of AI techniques that have been studied and how they can be used in different ways. We have also looked at the current AI-based tools for planning construction projects and talked about the results of recent studies on how AI can be used to plan construction projects. We've also talked about how AI could be used to plan construction projects in the future and how more research needs to be done in this area.

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The results show that AI has enormous potential for construction project planning. The use of AI techniques can improve project planning accuracy, reduce the time required for planning, and enable real-time updates to project schedules. For example, neural networks can be used to predict project outcomes with a high degree of accuracy, while genetic algorithms can optimize project schedules to minimize project duration or cost. Expert systems can provide recommendations for project scheduling based on historical data and expert knowledge, while fuzzy logic can incorporate uncertain or ambiguous information into decision-making processes.

Figure 11 Graph 1 Response to Question 1

Figure 12 Graph 2 Response to Question 2

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Figure 13 Graph 3 Response to Question 3

Figure 14 Graph 4 Response to Question 4

Figure 15 Graph 5 Response to Question 5

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5. Discussion

AI is being used to improve the speed and accuracy of planning for construction projects. In particular, machine learning and natural language processing are being used. Machine learning is used to find patterns, spot trends, and make models that can be used to plan and manage building projects. AI can also be used to automate tasks like scheduling, figuring out how much something will cost, and allocating resources. Natural language processing is used to interpret written language and provide insights into the nature of contracts and other documents related to construction projects. AI has the potential to cut down on mistakes and make construction sites safer by spotting things like structural flaws and dangerous materials and telling workers what to do to fix them. AI can also be used to optimize project scheduling, cost estimation, and resource allocation, which can help reduce costs and improve the efficiency of project delivery. AI can also be used to improve the accuracy and usability of contracts and other documents, which can help reduce disputes and improve the overall quality of construction projects.

Figure 16 Research WBS

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6. Conclusion

AI is a field that is growing quickly and could make it easier and more accurate to plan building projects. AI can be used to automate tasks like scheduling, estimating costs, and allocating resources. It can also be used to find patterns, spot trends, and make predictive models. AI can also be used to improve the accuracy and usability of contracts and other documents, which can help reduce disputes and improve the overall quality of construction projects. AI has the potential to reduce errors and improve the safety of construction sites, as well as optimise project scheduling, cost estimation, and resource allocation, which can help reduce costs and improve the efficiency of project delivery.

Figure 17 Research Project Gantt

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