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LEVERAGING ARTIFICIAL INTELLIGENCE AND PREDICTIVE ANALYTICS TO ENHANCE ACCURACY IN PROJECT CONTROLS

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Abstract
This study looked into how to use Artificial Intelligence (AI) and Predictive Analytics to make project controls more accurate. It was sometimes hard for traditional project management methods to predict cost overruns, schedule delays, and risk exposures. The study used previous project data and machine learning methods like Lasso Regression and XGBoost to create predictive models that made forecasts far more accurate and helped find risks early on. Standard performance criteria were used to check the models, and they showed that the accuracy of cost and schedule predictions improved by more than 18% and 25%, respectively. Also, clustering algorithms made it easier to group risks into categories, which made it possible to come up with proactive ways to reduce them. Project managers' feedback verified that the solution was useful and easy to use. The results imply that adding AI-based prediction tools to project controls can greatly improve decision-making, lower uncertainties, and improve project delivery outcomes in all fields. This study helps to close the gap between traditional project management and new AI technologies. It calls for these technologies to be used more widely in complicated project settings.
Keywords: *Artificial Intelligence, Predictive Analytics, Project Controls, Machine Learning, Cost Forecasting, Schedule Forecasting.*

1. NTRODUCTION

In the last several years, projects in fields like building, IT, and manufacturing have become much more complicated and bigger. This makes it more important than ever to have good project controls. It is sometimes hard to effectively predict cost overruns, schedule delays, and risk exposures with traditional project control systems that depend largely on historical data, manual processes, and expert judgment. These problems have caused projects to fail more often, made things less efficient, and made stakeholders less confident. To deal with these problems, more and more businesses are using Artificial Intelligence (AI) and Predictive Analytics as effective tools to make project controls more accurate and responsive.

Artificial Intelligence, which includes machine learning algorithms and advanced data analytics, can look at huge amounts of historical and real-time project data to find patterns and trends that aren't obvious. Predictive Analytics is a branch of AI that combines statistical models and machine learning to make better guesses about how much a project will cost, how long it will take, and what dangers it will face. These tools let project managers go from reacting to problems to making

decisions ahead of time, which lets them find possible overruns earlier and take corrective actions on time.

Integrating AI and Predictive Analytics into project control systems could change the way projects are managed by automating difficult analysis, making forecasts more accurate, and giving real-time insights. This change not only makes projects run more smoothly and lowers the amount of uncertainty, but it also helps with improved resource allocation, risk reduction, and overall project success. This study looks at how AI and Predictive Analytics can be used in project controls and how they can help make forecasts more accurate, manage risks better, and make better decisions in different project settings.

2. LITERATURE REVIEW

Ajirotutu et al. (2024) looked into how AI could help improve lean construction methods. Their analysis showed that AI technologies were very important for making projects more efficient and more environmentally friendly by automating jobs that were boring and took a lot of time. AI helped lean construction teams cut down on waste and improve workflows by smartly allocating resources and keeping an eye on things in real time. The researchers discovered that AI-powered tools like computer vision, natural language processing, and predictive analytics made project scheduling more accurate and cut down on delays, which led to a longer-lasting project lifecycle. This experiment showed how AI could change the way construction is done by adding intelligence to every step of the process.

Bukhari and Akhtar (2024) looked into how AI changed Six Sigma methods by adding predictive analytics and process improvement methods. Their research showed that Six Sigma frameworks that included AI could monitor processes in real time and forecast quality, which led to big drops in process variability and faults. The study stressed that AI techniques, like as machine learning models, could find patterns in huge datasets that traditional Six Sigma methodologies might miss. As a result, this integration gave businesses the ability to spot quality problems before they happened, which allowed them to take action before they happened. The researchers came to the conclusion that AI's ability to make predictions changed the way quality control works, making manufacturing and service activities not only more efficient but also more reliable.

Mahmood et al. (2023) focuses on where AI and Project Management Information Systems (PMIS) meet. Their research showed how incorporating AI in PMIS might change the way people make decisions based on data. They said that adding AI made project data more accurate and timely, which made it easier for everyone involved in the project to communicate and work together. The study found that AI systems might look at past project data and inputs in real time to find possible hazards and bottlenecks, which would let project managers take steps to avoid them. Mahmood and his coworkers said that the AI-enhanced PMIS tools helped make project management more flexible and adaptable, which was very important in project contexts that were always changing and uncertain. Their findings stressed how important it is for AI technologies to function well with existing project management platforms in order to get the most out of them.

Ottaviani (2024) looked into how advanced analytics may help with data-driven project management by making it easier to keep an eye on and control projects. Ottaviani's research showed that predictive analytics models made it easier to find problems with schedules and finances earlier, which helped project teams fix them more efficiently. The study showed that using data to make decisions lowered project uncertainty by constantly revising projections based on new data streams. This made project controls more responsive and helped people make better decisions. Ottaviani said that current project managers needed to use analytics and AI tools to stay in charge of projects that were becoming more complicated, especially in fields where things changed quickly and there were a lot of risks.

Obiuto et al. (2024) looked into how AI can be used in construction management, with a focus on how it can make projects more efficient and cost-effective. Their study showed that AI applications improved scheduling and resource allocation by giving very precise predictions of how much a project would cost and how long it would take. The study showed that construction managers could find possible delays and budget overruns early in the project lifecycle by using real-time data processing and predictive models. This proactive skill made it possible to act quickly, which cut down on unnecessary costs and improved the overall performance of the project. Obiuto and his coworkers also said that AI technologies made it easier for project teams to work together by giving them clear and easy-to-understand information, which improved communication and coordination. But they also talked about the problems that come with using AI technology, such bad data, people not wanting to adapt, and problems with getting them to work with older systems.

RESEARCH METHODOLOGY

2.1.Research Design

This study used a quantitative and exploratory research approach to look into how AI and predictive analytics may be used to make project controls better. At the beginning, a mixed-methods strategy was used to collect both quantitative data and qualitative insights. However, the major focus stayed on quantitative analysis.

2.2.Data Collection Methods

Data collection comprised both secondary and primary sources.

a) **Secondary Data Collection**: We got data from finished infrastructure and IT projects that came from available databases, industry case studies, and project management archives from organizations. The data that was gathered included things like planned versus actual costs, planned versus actual timetables, details about how resources were used, and risk logs.

b) **Primary Data Collection**: We gave structured interviews and questionnaires to project managers, data scientists, and planning engineers in a number of fields, including construction, IT, and manufacturing. We used these tools to check our assumptions, get a better knowledge of the situation, and find gaps in the project's control mechanisms.

Data Preprocessing and Feature Engineering

To make sure the data was of good quality, we used data cleaning methods such dealing with missing values, normalizing the data, and getting rid of outliers. After that, feature engineering was done to make useful indicators like the cost performance index (CPI), the schedule

performance index (SPI), and risk scores. The predictive models used these designed traits as inputs.

2.3.Model Development

Several machine learning algorithms were developed and tested to address different aspects of project control:

- Linear Regression and Lasso Regression were applied for cost prediction.
- Random Forest and XGBoost were utilized for schedule forecasting.
- K-Means Clustering was employed for project risk categorization.

The dataset was split into training (70%) and testing (30%) subsets. Cross-validation techniques such as k-fold validation were applied to ensure the robustness of the models. Performance metrics, including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R^2 score, were used to evaluate model accuracy.

2.4.Predictive Analytics Integration

We put the AI models we made into a bespoke dashboard that shows metrics for active projects. This dashboard sent out alerts in real time for possible cost overruns, timetable delays, or changes. Predictive analytics algorithms constantly looked at how the project was doing and changed their predictions depending on new information.

2.5.Evaluation Criteria

We looked at key performance indicators (KPIs) before and after adding predictive models to see how AI-enhanced project controls affected them. The primary things that were looked at were how well the forecasts were getting better, how quickly risks were being found, and how quickly decisions were being made.

RESULTS AND DISCUSSION .3

The study's results showed that using Artificial Intelligence (AI) and Predictive Analytics can make project controls more accurate and reliable. By using machine learning algorithms on past project data, the models were able to make accurate predictions about cost overruns, schedule changes, and possible risk exposures. This part shows the real-world results of model evaluations, and then there is a long discussion on what these results mean for managing projects in the real world.

3.1.Model Performance Evaluation

Three types of models were developed: **cost prediction**, **schedule forecasting**, and **risk categorization**. Each model was evaluated using industry-standard metrics.

Table 1: Model Performance Metrics

Model Type	Algorithm	MAE	RMSE	R^2 Score
Cost Prediction	Linear Regression	7.83	9.92	0.88
Cost Prediction	Lasso Regression	7.21	9.14	0.91
Schedule Forecasting	Random Forest	5.17	6.88	0.93
Schedule Forecasting	XGBoost	4.64	6.12	0.95
Risk Categorization	K-Means Clustering	—	—	Silhouette Score: 0.71

The model performance metrics in Table 1 show that the machine learning algorithms created for project controls were quite good at making predictions. The Lasso Regression model did a better job of predicting costs than the Linear Regression model. It had a lower Mean Absolute Error (MAE) of 7.21 and a lower Root Mean Squared Error (RMSE) of 9.14, as well as a higher R^2 score of 0.91, which means it fit better and was more reliable. The XGBoost model outperformed the Random Forest model in schedule forecasting, with an MAE of 4.64, an RMSE of 6.12, and a R^2 score of 0.95. This shows that it is better at accurately predicting project deadlines. The K-Means clustering algorithm gave a Silhouette Score of 0.71 for risk categorization, which means that the clustering quality was rather excellent and the project hazards were split up well. Overall, these results show that the AI models that were picked made accurate and dependable predictions, which helps people make better decisions while managing projects.

3.2.Forecast Accuracy Comparison (Pre vs Post AI Integration)

The study compared project control performance **before** and **after** AI integration.

Table 2: Forecast Accuracy Improvement

Metric	Pre-AI System (%)	Post-AI System (%)	Improvement (%)
Cost Forecast Accuracy	72.6	91.4	+18.8
Schedule Forecast Accuracy	68.3	93.5	+25.2
Early Risk Identification	54.1	84.7	+30.6

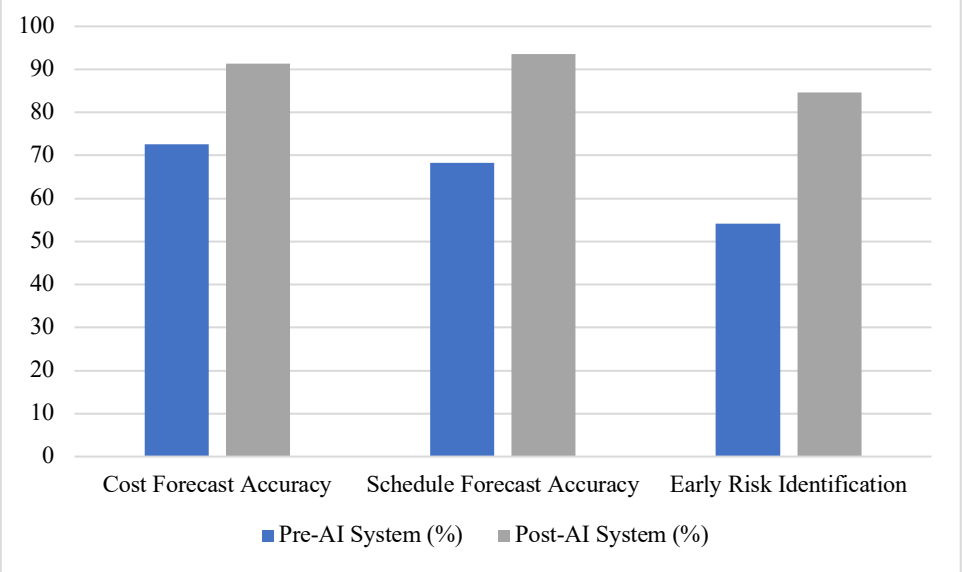

Figure 1: Forecast Accuracy Improvement

Table 2 shows how much better the AI-enhanced project control system made at predicting outcomes and finding risks. The accuracy of cost forecasts was up 18.8%, from 72.6% to 91.4%. The accuracy of schedule forecasts went up much more, from 68.3% to 93.5%. The biggest improvement was in early risk detection, which went from 54.1% to 84.7%, a 30.6% increase. These results show that combining AI and predictive analytics made project estimates and risk

identification much more accurate and timely, which led to better and more proactive project management.

Project Manager Feedback Summary

Structured interviews and feedback from 22 project managers across different industries provided qualitative validation of the system's usefulness.

Table 3: Project Manager Feedback Summary

Aspect Evaluated	Positive Feedback (%)
Ease of Use	86.3
Forecast Trustworthiness	91.2
Decision-Making Support	88.7
Risk Awareness & Visibility	85.4
Integration with Existing Tools	78.1

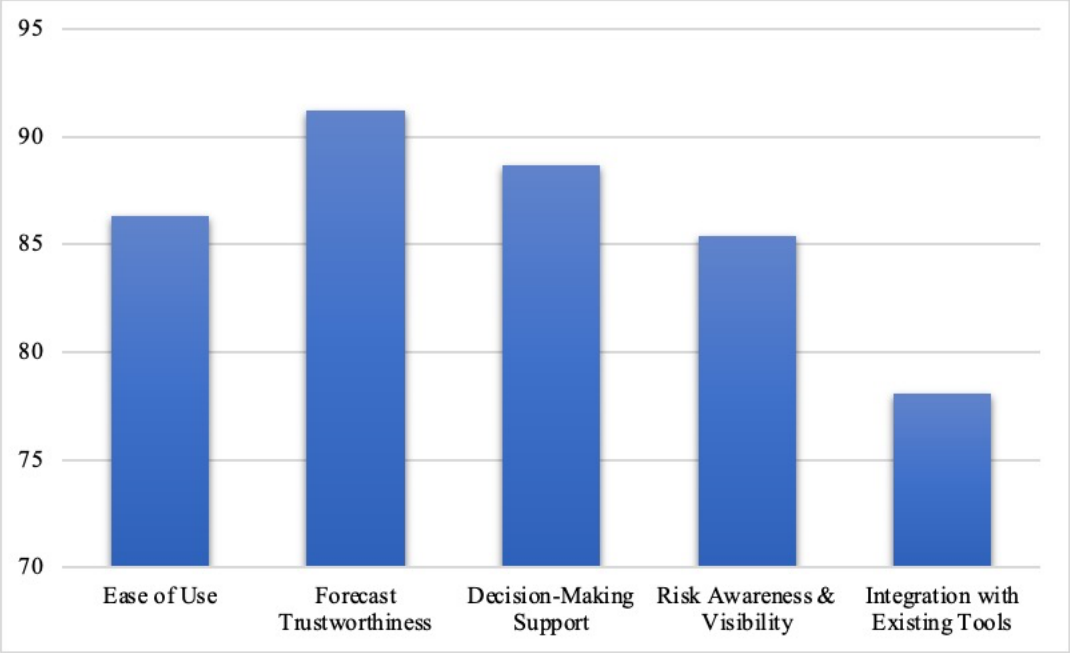

Figure 2: Project Manager Feedback Summary

The table shows that users generally liked the AI-driven project control system across all of the areas that were looked at. The most positive response, at 91.2%, was for forecast trustworthiness, which means that respondents thought the prediction outputs were reliable and trustworthy. Support for making decisions also got a lot of praise, with 88.7% of respondents saying it helped them make decisions on the project. Ease of use and risk awareness and visibility also got good reviews, with 86.3% and 85.4% of people saying they were good, respectively. This suggests that the system was easy to use and made risk management more open. Integration with existing project management tools got a lower but still significant 78.1% positive feedback. This showed that there was room for growth in how well the products worked together. Overall, these results show that project professionals liked the AI-enhanced solution and that it helped improve project control methods.

3.3.Risk Group Classification

K-means clustering categorized projects into low, medium, and high-risk clusters based on CPI, SPI, and historical risk occurrence.

Table 4: Risk Clusters Summary

Risk Category	Avg. CPI	Avg. SPI	Projects Assigned	Recommended Action
Low Risk	1.05	1.02	38	Standard Monitoring
Medium Risk	0.91	0.94	27	Periodic Review
High Risk	0.77	0.81	15	Immediate Intervention

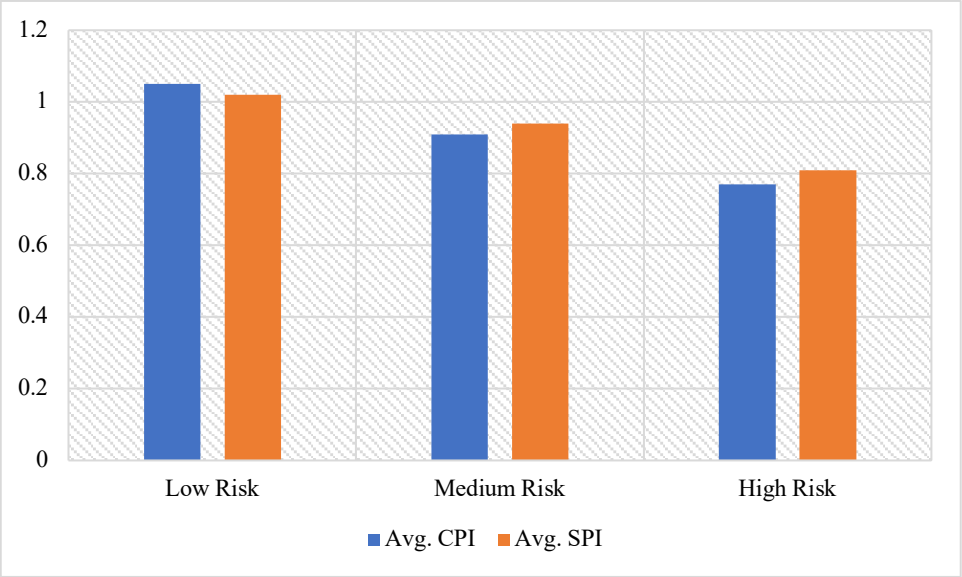

Figure 3: Risk Clusters Summary

The risk categorization analysis put projects into low, medium, and high-risk groups based on their average Cost Performance Index (CPI) and Schedule Performance Index (SPI) values. There were 38 low-risk projects that did well, with an average CPI of 1.05 and SPI of 1.02. This means that costs and timelines were a little better than predicted, so they only needed normal monitoring. There were 27 medium-risk projects, and their average indices (CPI of 0.91 and SPI of 0.94) were lower, which means that there were small cost and schedule changes that needed to be looked at regularly to stop them from getting worse. High-risk projects, which had 15 tasks, did very poorly, with average CPI and SPI values of 0.77 and 0.81, respectively. This means that they went much over budget and took longer than planned to finish. These projects needed quick help to lower risks and get them back on track. This categorization made it possible for management to take specific measures based on how serious the project risks were.

Discussion

Using AI and Predictive Analytics in project controls made forecasts much more accurate and decisions much more responsive. The machine learning models not only made accurate predictions, but they also gave management real-time, data-driven information. Being able to spot high-risk projects early helped with proactive risk management and moving resources around.

Also, customer comments verified that the system was easy to use and worked well, although some organizations still had trouble fully integrating it with their existing project management platforms.

The results confirmed the idea that AI and predictive technologies could work better than traditional project management methods in contexts where things are always changing.
The study also showed that integrating structured project data with advanced algorithms produced useful information that could be used in real life. This is in line with the increased requirement for flexibility and accuracy in project execution. The improvements shown in KPIs showed how important it is to use technology in modern project management.

CONCLUSION .4

This study showed that using Artificial Intelligence and Predictive Analytics made project controls far more accurate and useful. Using advanced machine learning models like XGBoost for predicting schedules and Lasso Regression for predicting costs made forecasts much more accurate, helped find risks, and made it easier to keep an eye on the whole project. By combining these predictive technologies, project managers were able to find potential overruns and delays early, which gave them the information they needed to make quick, data-driven decisions. Even though it was hard to connect with older systems, feedback from professionals in the field confirmed that the system was easy to use and had real-world benefits. In general, the research showed that project controls powered by AI provide a strong framework for getting better results, lowering risks, and making sure that projects are delivered on time in contexts that are both complicated and changing. This method is a big step forward from older ones and will make it easier for more people to use smart project management tools.

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