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Developing a Machine Learning-based Cost Prediction Model for Construction Projects using Particle Swarm Optimization

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Abstract : Accurate cost prediction is essential for effective project management and decision-making in the construction industry. This study aims to develop a cost prediction model for construction projects using Machine Learning techniques and Particle Swarm Optimization (PSO). The research utilizes a comprehensive dataset containing project cost estimates, actual costs, resource details, and project performance metrics from a road reconstruction project. The methodology involves data preprocessing, feature selection, and the development of an Artificial Neural Network (ANN) model optimized using PSO. The study investigates the impact of various input features, including cost estimates, resource allocation, and project progress, on the accuracy of cost predictions. The performance of the optimized ANN model is evaluated using metrics such as Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R-squared. The results demonstrate the effectiveness of the proposed approach in predicting project costs, outperforming traditional benchmark models. The feature selection process identifies the most influential variables contributing to cost variations, providing valuable insights for project managers. However, this study has several limitations. Firstly, the model's performance may be influenced by the quality and quantity of the dataset used. A larger and more diverse dataset covering different types of construction projects would enhance the model's generalizability. Secondly, the study focuses on a specific optimization technique (PSO) and a single Machine Learning algorithm (ANN). Exploring other optimization methods and comparing the performance of various ML algorithms could provide a more comprehensive understanding of the cost prediction problem. Future research should focus on several key areas. Firstly, expanding the dataset to include a wider range of construction projects, such as residential buildings, commercial complexes, and infrastructure projects, would improve the model's applicability. Secondly, investigating the integration of additional data sources, such as economic indicators, weather data, and supplier information, could enhance the predictive power of the model. Thirdly, exploring the potential of ensemble learning techniques, which combine multiple ML algorithms, may further improve cost prediction accuracy. Additionally, developing user-friendly interfaces and tools to facilitate the adoption of the proposed cost prediction model in real-world construction projects would be a valuable contribution to the industry. The findings of this study have significant implications for construction project management, enabling proactive cost estimation, resource allocation, budget planning, and risk assessment, ultimately leading to improved project performance and cost control. This research contributes to the advancement of cost prediction techniques in the construction industry and highlights the potential of Machine Learning and PSO in addressing this critical challenge. However, further research is needed to address the limitations and explore the identified future research directions to fully realize the potential of ML-based cost prediction models in the construction domain.

Keywords : cost prediction, construction projects, machine learning, artificial neural networks, particle swarm optimization, project management, feature selection, road reconstruction
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