JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Study of Modified Particle Swarm Optimization (MPSO) algorithm-based claim management system for construction claim and disputes in infrastructure projects)

[1]Swapnil S Jadhav, [2]A.V. Hankare

[1]Student, Final Year MTech Civil Engineering, TKIET, Warananagar Kolhapur
[1]Assistant Professor, Department of Civil Engineering, TKIET, Warnanagar Kolhapur

Abstract: This study has been undertaken to apply the Modified Particle Swarm Optimization (MPSO) algorithm in the claim management system for assessing risks associated with construction claims in infrastructure projects represents a significant advancement in project management and risk mitigation. The MPSO algorithm, with its enhanced capabilities and adaptability, has demonstrated its efficacy in optimizing the assessment process, thereby improving the accuracy and efficiency of risk evaluation.

To carry out study the 05 completed projects are selected, these projects were completed between 2013 to 2018, these projects were delayed under various circumstances, the cost of the project has been increased as well. The value of claim and the delay is analyzed to know optimum values of the time and corresponding increased costs.

I. Introduction

Construction projects typically entail complexity and prolonged completion periods, rendering them susceptible to contractual claims and disputes. Across India and abroad, numerous projects struggle to adhere to budgetary constraints and timelines, leading to additional expenditures in the form of claims.

This report endeavors to analyze the costs associated with contractual claims and time delays, aiming to identify optimal values for five completed projects. Leveraging a Modified Particle Swarm Optimization (MPSO) algorithm-based claim management system, the study seeks to optimize outcomes and mitigate the impact of disputes in construction projects.

For this study, five completed projects were selected, each having experienced delays under various circumstances resulting in increased project costs upon completion. The data regarding the value of claims and the duration of delays were extracted from the completion certificates issued by government organizations. These certificates were further scrutinized to ascertain the reasons behind the escalation in project costs. The recorded values of contractual claims and extended project durations served as input variables for the MPSO model, which then identified the optimal values for each parameter across all five projects.

The primary aim of this study is to mitigate the financial and temporal repercussions associated with construction claims. By minimizing the combined impact of project delay durations and additional costs, the research seeks to provide an optimal solution for construction claims management.

Additionally, the model's output offers insights into project risks at the early stages, enabling the application of risk mitigation strategies. This analysis aids in the identification of project risks and the formulation of corresponding risk mitigation plans, ultimately enhancing project management practices.

Kiani et al. (2021) have introduced an updated iteration of Particle Swarm Optimization (PSO) designed to overcome the shortcomings of conventional PSO in estimating PV parameters. To improve PSO's efficacy and ensure a balanced exploration of both local and global solutions, this study initiates with the implementation of a sine chaotic inertia weight mechanism. Subsequently, two distinct methods are employed to regulate acceleration coefficients. To optimize these coefficients, a tangent chaotic approach is utilized, aiming to identify the most optimal solution.

Freitas et al. (2020) delineated the iterative nature of the PSO optimization algorithm, which aims to progressively refine a problem by initiating with a population of candidate solutions, referred to as a swarm of particles. Within this swarm, each particle is cognizant of both the global best position, representing the most optimal solution found within the entire swarm, and its individual best position, reflecting its own optimal solution discovered during the search process. As the particles traverse the search space, they dynamically adjust their positions in pursuit of the global minimum. The PSO algorithm is governed by three parameters: one control parameter and two learning parameters, each playing a crucial role in the search process.

Kermanshachi et al. (2018) discovered that the issue of subpar construction performance has been a longstanding concern among both academic researchers and industry practitioners. With the economy experiencing continuous growth, intense competition, and rapid changes within the construction sector, many businesses are compelled to consistently monitor and improve their performance. Moreover, research has shown that effectively implementing the three Engineering, Procurement, and Construction (EPC) phases can lead to a construction performance that is notably efficient. Specifically, the performance of each EPC phase can be evaluated based on factors such as schedule adherence, cost management, and quality outcomes.

II. Objective of the study

Within the construction sector, handling claims stemming from delays and added expenses presents a multifaceted challenge. Construction endeavors frequently encounter uncertainties, resulting in project setbacks and increased expenditures. Streamlining the resolution of construction-related claims, which hinge on these factors, is paramount for project efficacy. This issue endeavors to utilize Particle Swarm Optimization (PSO) to unearth an ideal resolution for managing construction claims. Its goal is to mitigate the collective repercussions of project delay durations and supplementary costs, thereby enhancing overall project management efficiency.

III. Data collection

Collecting data is a pivotal aspect of this project, particularly in developing the MPSO model and analyzing numerous inputs from various projects. This data is sourced from governmental and semi-governmental entities across India, focusing on completed infrastructure projects such as new railway line constructions, bridges, flyovers, barrages, and highway constructions, spanning from 2004 to 2022. The completion certificates of these projects are obtained from these organizations for analytical and educational purposes.

These projects are typically awarded to contractors through the least cost method (LSM) via open bidding processes. They encompass various contract types including EPC contracts, Item Rate Contracts, BOQ contracts, and Percentage Rate Contracts. Depending on the contract form, the likelihood of contractual claims varies; for instance, EPC contracts are more susceptible to such claims compared to other contract forms. However, both item rate contracts and BOQ type contracts also have a high likelihood of claims. The escalation of project costs may result in additional expenses and time, leading to project delays. Therefore, effective contract management is paramount. A successful project is one that is completed within budget and on time.

The objective of this study is to identify projects with maximum variations in completion costs, longest durations, and highest contractual claims. Data from five completed projects were analyzed, focusing on contractual claims, types of claims, claim amounts, and their resolutions. Two input variables, namely extended time in years and claim amount in crores, were utilized. The output is the optimal claim duration, directly correlated with the resource cost involved in claim settlement.

IV. Data and Sources of Data

For the study, five completed projects were chosen, each experiencing delays and cost increases due to various circumstances. Information regarding the project's completion costs, including the value of claims and the duration of delays, was extracted from government-issued completion certificates. Further analysis of these certificates was conducted to discern the reasons behind the escalated project costs. The values of contractual claims and additional time required to finalize the projects were recorded. These two parameters served as input variables for the MPSO model, enabling the identification of the most optimal values for each parameter across all five.

Table 1: Project Data

Sr	Project type	LOA No	LOA Date	Original Contract Value in INR	Value on Completion in INR	Original date of completion	Actual date of completion
1	Foot Over Bridge	A/08-2018/Estate	23-04-2018	4,01,67,899.86	4,77,09,845.94	07-09-2018	30-04-2019
2	Foot Over Bridge	A/37-2015/HQ	23-12-2015	1,50,35,479.15	2,07,56,387.89	13-10-2016	25-04-2018
3	Foot Over Bridge	A/36-2015/HQ	23-12-2015	2,21,79,821.86	3,00,14,714.00	27-10-2016	14-12-2017
4	Repair of ROB	A/03-2017/Estate	16-03-2017	1,37,91,630.96	1,57,54,830.22	04-12-2018	29-12-2019

5	Locomotive shed	Dy. CE/CG/CA/ DLS /KYN/ 2013/01/RT	15-11-2013	2,08,37,828.27	2,63,16,168.00	14-11-2014	31-01-2016

Table 2: Variables

Sr	Section / location	Project Ref	Variable-1		Variable-2	
			Time in Months	Time in Years	Claim Value in Rs.	Claim Value in Crores
1	Foot Over Bridge	Project-01	7	0.70	75,41,946.08	0.754
2	Foot Over Bridge	Project-02	18	1.80	57,20,908.74	0.572
3	Foot Over Bridge	Project-03	13	1.30	78,34,892.14	0.783
4	Repair of ROB	Project-04	12	1.20	19,63,199.26	0.196
5	Locomotive shed	Project-05	14	1.40	54,78,339.73	0.548

V. THEORETICAL FRAMEWORK

Two input variables, namely extended time in years and claim amount in crores, were utilized. The output is the optimal claim duration, directly correlated with the resource cost involved in claim settlement.

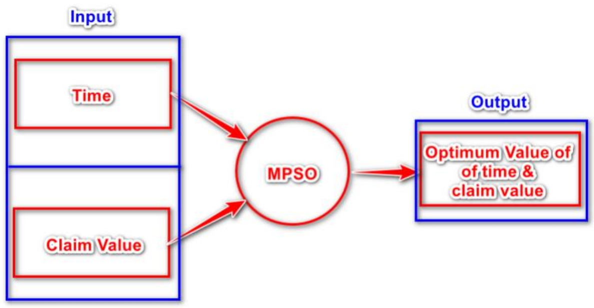

Figure 1: Process of PSO

VI. APPLICATION OF PSO

In the construction industry, managing claims arising from delays and additional costs is a complex task. Construction projects often face uncertainties leading to project delays and incurring additional costs. Optimizing the resolution of construction claims involving these two variables is crucial for project success. This problem aims to leverage Particle Swarm Optimization (PSO) to find an optimal solution for construction claim management by minimizing the combined impact of project delay duration and additional cost.

Objective Function:

Minimize the construction claim management objective function:

Minimize

$F(x) = X_1^2 - X_1X_2 + X_2^2 + 2X_1 + 4X_2 + 3$

PSO Parameters:

1. Quantity of particles within the swarm defines the Swarm Size (N).
2. Inertia Weight (w) influences how a particle's preceding velocity shapes its subsequent movement.
3. Cognitive Parameter (c1) dictates the degree to which a particle gravitates toward its personal best solution.
4. Social Parameter (c2) governs the extent to which a particle is drawn towards the overall best solution found within the swarm.

A. PARAMETER FOR SELECTION OF DATA.

The convergence of Particle Swarm Optimization (PSO) can be significantly influenced by the judicious selection of control parameters, such as inertia weight and acceleration coefficient. Over time, research has extensively focused on the acceleration coefficient's impact on self and social cognition, playing a crucial role in PSO convergence.

Government-issued completion certificates are scrutinized to gather information including the scope of work, project award date, project cost, project duration, actual completion date, actual completion cost, and details of claims along with the time taken to settle them.

A total of five projects spanning various sectors are examined for analysis, necessitating a minimum of two variables. These variables—Project Delay Duration and additional costs incurred due to claims—are computed by determining the difference between the actual completion time and the original project completion time. This difference, initially in months, is converted into years for simplicity. The second variable is derived by subtracting the project's completion cost from its original cost, with the claim value being converted into crores.

Non-negative values are also factored into the analysis to assess the impact of claim amounts when projects are completed ahead of schedule and under budget.

B. THE STOPPING CRITERIA FOR ITERATIONS IN THE STUDY ARE AS FOLLOWS:

Termination occurs when the maximum number of iterations is reached. However, if this limit is too low, termination may happen prematurely before a satisfactory solution is achieved. This criterion is often combined with other termination conditions or used independently when the objective is to estimate the best solution within a fixed timeframe. In this study, the maximum number of iterations is set at 20.

ii. Termination happens when an acceptable solution is attained. This criterion ends the search once an optimal solution is found for the objective function, provided an acceptable error is reached. However, it may terminate on a sub-optimal solution if the optimal solution is too large or fail to terminate at all, particularly for basic PSO due to challenges in refining solutions. This condition assumes prior knowledge of the optimal solution, which may not always be available.

iii. Termination occurs when no improvement is observed over a certain number of iterations. Various measures of improvement can be used, such as small changes in average particle positions or near-zero average particle velocities, indicating minimal position updates and lack of significant improvements.

iv. Termination occurs when the normalized swarm space approaches zero. The objective function adopted for analysis focuses on minimization, aiming to obtain the minimum value of the pair. Iteration ends when the difference between the objective function values of consecutive iterations is zero, signifying no further need for analysis.

VII. CONCLUSION

The implementation of the Modified Particle Swarm Optimization (MPSO) algorithm in the construction claim management system marks a significant stride in project management and risk mitigation for infrastructure projects. Through its enhanced capabilities and adaptability, MPSO has demonstrated effectiveness in streamlining the assessment process, thereby improving accuracy and efficiency in risk evaluation.

By integrating MPSO, the claim management system can adeptly navigate the intricacies of infrastructure projects, better identifying potential risks associated with construction claims. This approach empowers project managers and stakeholders to make informed decisions, allocate resources wisely, and implement preemptive measures to mitigate risks before they escalate.

The aim of this study is to identify the most suitable project for in-depth analysis and application of the PSO method. Optimizing the resolution of construction claims, involving key variables such as project delay duration and additional cost, is crucial for project success. Leveraging Particle Swarm Optimization (PSO), the study seeks to find an optimal solution for construction claim management by minimizing the combined impact of these variables.

Data is gathered from various sources to identify the best values for these crucial project factors. Completion certificates provide essential information such as project completion periods and claim values, serving as input variables for the MPSO model. The output is the optimal values for time and claim amounts.

The collected data undergoes analysis using the MPSO algorithm, with calculations performed using conventional mathematical formulas. To validate the accuracy of the MPSO results, the model is tested with different parameters, yielding consistent outcomes.

In this study, data analysis is conducted using the MPSO algorithm within MS Excel, revealing that project that exhibits the optimal solution. The results are further verified by recalculating them with varied MPSO parameters, consistently yielding the same outcomes. Thus, the project duration and cost of project which emerge as the optimal values.

VIII. Reference

[1]. Kiani, A.T.; Nadeem, M.F.; Ahmed, A.; Khan, I.A.; Alkhammash, H.I.; Sajjad, I.A.; Hussain, B. An Improved Particle Swarm Optimization with Chaotic Inertia Weight and Acceleration Coefficients for Optimal Extraction of PV Models Parameters. Energies 2021, 14, 2980

[2]. Freitas, D.; Lopes, L.G.; Morgado-Dias, F. Particle Swarm Optimization: A Historical Rev2iew up to the Current Developments. Entropy 2020, 22, 362.

[3]. Liu, Q., Wei, M. K., Zhou, Q., Cai, S. R., Jiang, L., Zhou, H., et al. (2020). Research on capacity optimization configuration of the Southwestern China microgrid considering electricity cost and system self-power supply reliability. Power Syst. Prot. Control48 (10), 139–145.

[4]. Kong, X.; Zhang, T. Non-Singular Fast Terminal Sliding Mode Control of High-Speed Train Network System Based on Improved Particle Swarm Optimization Algorithm. Symmetry 2020, 12, 205

[5]. Safapour, E. Kermanshachi, S. Identifying early indicators of manageable rework causes and selecting and mitigating best practices for construction. J. Manag. Eng. 2019, 35, 04018060.

[6]. Garg, H. A Hybrid GSA-GA Algorithm for Constrained Optimization Problems. Inf. Sci. 2019, 478, 499–523.

[7]. Kermanshachi, S.; Anderson, S.; Molenaar, K.R.; Schexnayder, C. Effectiveness Assessment of Transportation Cost Estimation and Cost Management Workforce Educational Training for Complex Projects. In Proceedings of the ASCE International Conference on Transportation & Development, Pittsburgh, PA, USA, 15–18 July 2018

[8]. Deetjen, T. A., Martin, H., Rhodes, J. D., and Webber, M. E. (2018). Modelling the optimal mix and location of wind and solar with transmission and carbon pricing considerations. Renew. Energy120, 35–50.

[9]. Cui, Q.; Li, Q.; Li, G.; Li, Z.; Han, X.; Lee, H.P.; Liang, Y.; Wang, B.; Jiang, J.; Wu, C. Globally Optimal Prediction-Based Adaptive Mutation Particle Swarm Optimization. Inf. Sci. 2017, 418–419, 186–217.

[10]. Dong, W.Y.; Kang, L.L.; Zhang, W.S. Opposition-Based Particle Swarm Optimization with Adaptive Mutation Strategy. Soft Compute. 2017, 21, 5081–5090