

# Time-cost-quality optimization using an invasive weed algorithm with activity preemption in construction projects

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## ABSTRACT

In last decade, various methods are created to optimize time, cost, and quality. Solving such problem in large scale is too hard using traditional methods in logical time. Recently, researchers are focused on meta heuristic algorithm to solve time-cost-quality tradeoff problems. How to make balance among time, cost, and quality parameters is so critical in construction projects management. In this study, an invasive weed optimization algorithm is applied to solve the problem. In proposed model, activity time is changed so that maximum usage of resources is obtained. In other words, it is possible to perform some activity simultaneously if their duration is increased which causes to decrease time, cost and increase project quality. Obtained results indicate the advantages of proposed algorithm. Finally, to validate the proposed model a small size instance problem is created and solved by GAMS software optimally and compared with proposed algorithm results in MATLAB software. Results show that both pareto solution obtained is almost identical, then it validates the algorithms for large scale problem.

## KEYWORDS

Time, Cost, Quality, Invasive Weed Algorithm, Construction Projects

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## 1. Introduction

According to complexity of projects, it seems unlikely that project goals will be achieved without planning. Project planning and controlling is one the most important part of project management. Project scheduling to gain maximum quality and minimum cost in the least time is project management. Thus, planning process is one the most significant principles in construction projects successful [1]. To generate a balance between time and cost of project and increasing efficiency several ways to solve time-cost tradeoff problems and find an optimum combination of activity mode are developed such as mathematical programming models [2,3,4], heuristic methods [5,6] and meta heuristic techniques [7,8].

In multi-objective and multi-mode project scheduling problems solution space is increased exponentially in medium and large scale problem due to different execution modes that available for activities. These kind of multi-objective problems are known as NP-hard [9]. Therefore, meta heuristic algorithm is used to solve problem. Many meta heuristic algorithms are developed to solve time-cost-quality tradeoff problem optimally, for example, simulated annealing algorithm by Taheri Amiri, et al. [10], and genetic algorithm by Mungle, et al. [11].

In this study, time, cost and quality with activity preemption is considered. Activity preemption, as principles of lean thinking approach is considered to remove waste. Proposed model are solved by invasive weed optimization algorithm. Furthermore, to validate the proposed model a small size instance problem is created and solved by GAMS software optimally and compared with proposed algorithm results in MATLAB software.

## 2. Results and discussion

As said above, an invasive weed optimization algorithm is developed to solve time, cost, and quality tradeoff problem. To do this end, a three objective model considering activity preemption is developed. Then, two instance problems are solved by proposed algorithm for performance evaluation. On the other hand, a small size problem is used to assess a meta heuristic algorithm. Afterward, an e-constraint method is applied to solve problem exactly due to multi-objective model. Each objective is optimized separately and the best value is recorded as well as upper bound of each ones. Then, one main objective is considered and others are set as constraints.

In this study, total cost is considered as main objective function and two others are set as constraint. To obtain Pareto solution, different values of objectives are considered. It is possible some combination of objective points do not have feasible solution. This problem is solved by GAMS software less than one minute on dual core system with CPU 3GHz and RAMS 2GB. Moreover, proposed algorithm able to find Pareto solution less than about 40 seconds. Results obtained from two methods are compared that indicate the suitable performance of invasive weed optimization algorithm. Furthermore, completion time and total cost of project states the mathematical model validation.

## 3. Conclusion

In construction project, time, cost and quality management are most important goals of project management so that it performs in minimum completion time with least cost and acceptable quality. By taking advantage of the systemic approach and using new management tools, faster steps can be taken to achieve these goals. A scheduling planning tried to reduce time, cost and maximize quality and decrease job preemption, then resource unemployment and cost is declined. Invasive weed optimization algorithm is presented a set of solutions that makes manager to take decision more suitable.

In order to validate proposed method, two examples as case study are considered and solved by it which is obtained acceptable results. The results state that proper and efficient solution is achieved. It can be inferred that a suitable combination of activity execution mode and its sequence based on precedence relationships should be set to obtain a solution with balanced completion time, execution cost and delay time in resources. Finally, after activity mode selection scheduling planning should be set so that preemption is minimized. Furthermore, proposed problem is solved exactly with GAMS software on small size and compared by developed algorithm. Results indicate the appropriate performance of proposed algorithm. For future work direction, resource constrained, multi-mode activity, and multi-skilled one are suggested.

## 4. References

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