

# Optimisation of Construction Resource Allocation and Levelling Using Genetic Algorithm

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**ABSTRACT:** Resource allocation and levelling is one of the top challenges in construction project management, due to complex nature of the construction projects. CPM and PERT is most commonly used methods for scheduling of construction projects. However it is not capable of minimising undesirable fluctuations in resource utilisation profile. This research describes a Genetic algorithm approach to resource levelling and allocation in construction industry. The procedure which is used in this paper finds an optimum set of tasks and priorities that generate better-levelled resources profiles using Genetic Algorithm in MATLAB software.

**KEYWORDS:** Resource allocation, Resource levelling, Genetic algorithm, MATLAB

## I. INTRODUCTION

Critical path method and program evaluation and review technique have been used for planning and scheduling large scale construction projects. In every construction project each activity is processed after all the predecessors activities are finished. The main purpose of scheduling is to minimize the total duration of the project. In last several years costs of construction resources have progressively rises. Today resource management is one of the most important parts of the construction project management. Several resource levelling models are designed to minimize resource fluctuations by using the floats available to keep duration of the project unchanged. This paper brings out a model of optimisation using Genetic Algorithm (GA) for resource allocation and levelling. In this model, objective function optimizes both resource allocation and levelling simultaneously using Genetic algorithm in MATLAB software. Genetic Algorithm has several advantages as it consider the objectives of resource allocation and levelling all together. Genetic algorithm has more suppleness to solve scheduling problems because of no fixed heuristic rule.

## II. RELATED WORK

Tarek (1999) presented a GA based algorithm which considered resource leveling and allocation and minimized the moment of the resource histogram around the horizontal axis (time). GAs employs a random yet directed search for locating the globally optimal solution (Goldberg 1989). Genetic Algorithms (GAs) are search procedures that combine an artificial survival of the fittest strategy with genetic operators abstracted from nature [Michell 1998]. In this paper model is presented double moment concept which originally was proposed by Tarek (1999). In this process,  $M_y$  takes into consideration the resource utilization period in addition to  $M_x$  that considers the resource fluctuation.

## III. RESOURCE ALLOCATION AND LEVELLING

In construction projects resources are always limited and limitation on resources can considerably affect the performance and completion of activities on the scheduled time and can cause the project to be extended beyond the

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scheduled duration. Various activities of the project are to be scheduled in such a manner that there is best possible utilization of available resources. The main objective of any organization is not to waste the resources. There are some optimization methods and heuristics methods for solving the resource allocation and levelling problems.

Resource allocation is related with conveying the required number of those resources acknowledged in the previous step to each activity acknowledged in the plan. It does not follow any stable blueprint, sometimes activity which requires fewer resources initially may require more or same resources in next stages of the activities. A resource levelling is the process that ensures resource demand will not exceed resource availability.

## IV. GENETIC ALGORITHM

Genetic algorithms (GAs) were invented by John Holland in the 1960s and were developed by Holland and his students and colleagues at the University of Michigan. In contrast with evolution strategies and evolutionary programming, a genetic algorithm (GA) is a search technique used in computing to find true or approximate solutions to optimization problems. It is a global search heuristics. It is an evolutionary algorithm that uses techniques inspired from evolutionary biology such as mutation, selection and crossover. Genetic algorithm uses genetics as its model of problem solving. It handles the population of possible solutions; each solution is represented by chromosome which is just a theoretical representation. GAs work with a family of solutions, known as the "current population" from which the "next generation" of solutions is obtained, better solutions from one generation to the next are progressively obtained [Harmanani 2001]. GA procedure begins by generating an initial collection (referred to as population) of random solutions that are programmed in the form of strings called Chromosomes. Each individual Chromosome represents one solution that is better or worse than others in the population. The fitness of each solution is determined by evaluating its performance with respect to an objective function. To stimulate the natural survival of the fittest process, best Chromosomes exchange information to produce offspring that are evaluated and can replace fewer members in the population.

### Application of GA to resource allocation and levelling

The minimum resource moment algorithm was improved using both  $M_x$  and  $M_y$  resource moments. Resource fluctuations is represented by  $M_x$  and the resource utilisation is represented by  $M_y$ . When the combined value of these moments is minimum that means resources are efficiently utilised. The random activity priorities and the combined moments approach from the basis of the optimisation process.

## V. MATLAB IMPLEMENTATION

GAs procedure is implemented on MATLAB software. A model is programmed in MATLAB using genetic algorithm for optimisation of resource allocation and levelling. Problem solving model in MATLAB requires the relevant data that is activity, predecessors, resource availability and resources requirements per day.

### Performing Optimisation Process

This application is performed to optimize the process of the resource allocation and levelling on the construction project having 20 activities and for ease we took only one type resource for allocation and levelling. Optimization options are set as follows-

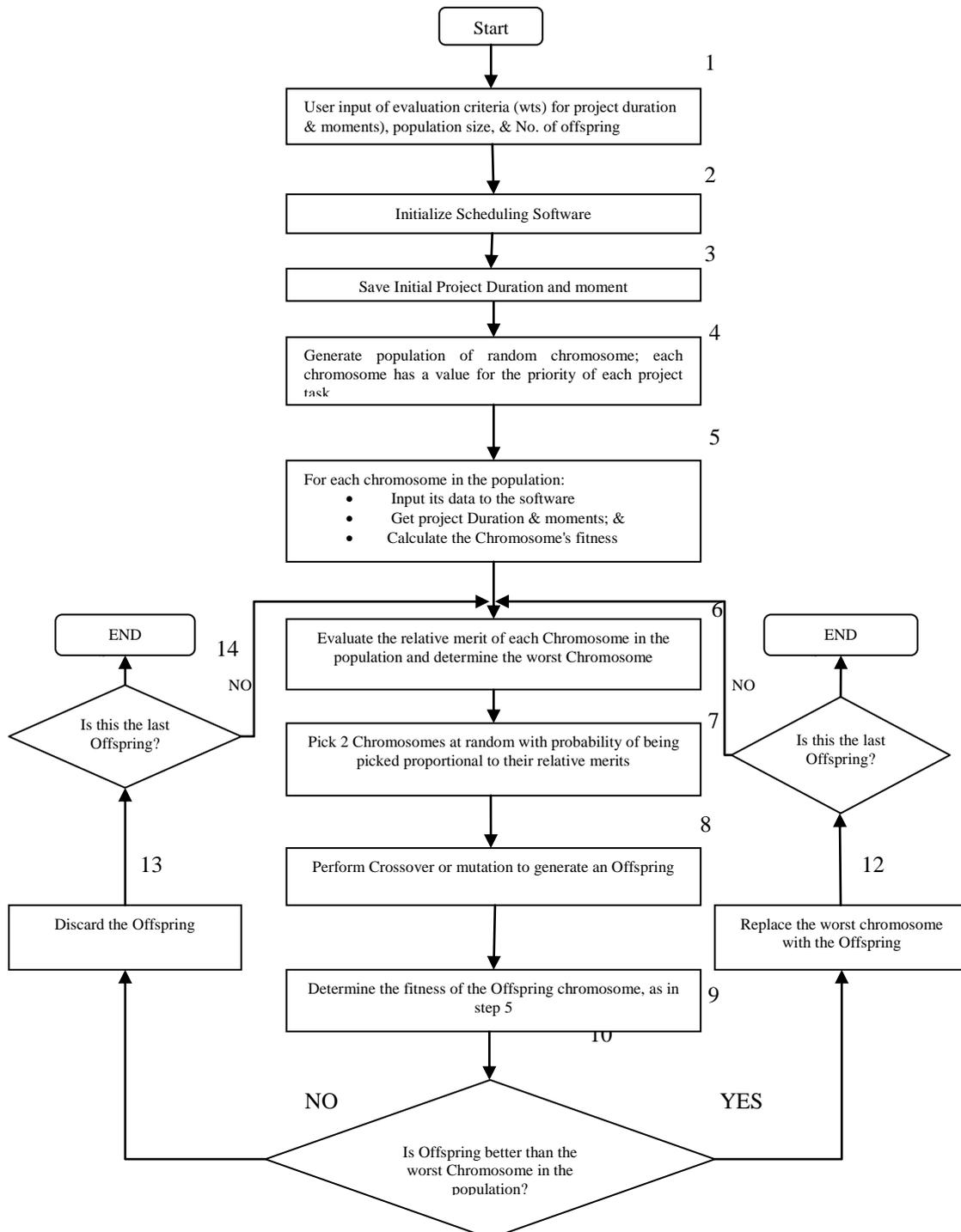
Options of GA

Population Size: number of the population.

Crossover Fraction: Fraction of the population that is not mutated.

Stopping conditions: as GA gives results that shows no further improvements.

Implementing the proposed GA procedure on software simplifies the implementation process and provides project managers with an automated tool to improve the results of their familiar software. In this study MATLAB software is selected for implementing the GA procedure, for the reasons mentioned earlier as well as its ease of use and programmability features. The detailed GA procedure is shown in figure 1



**Figure 1 Genetic Algorithm Procedure**

The proposed model in this paper comprises processing project data in MATLAB software and optimizing resource allocation and leveling using genetic algorithms program. The detailed procedure of optimizing process of resource allocation and leveling in MATLAB using GA is shown in figure 2.

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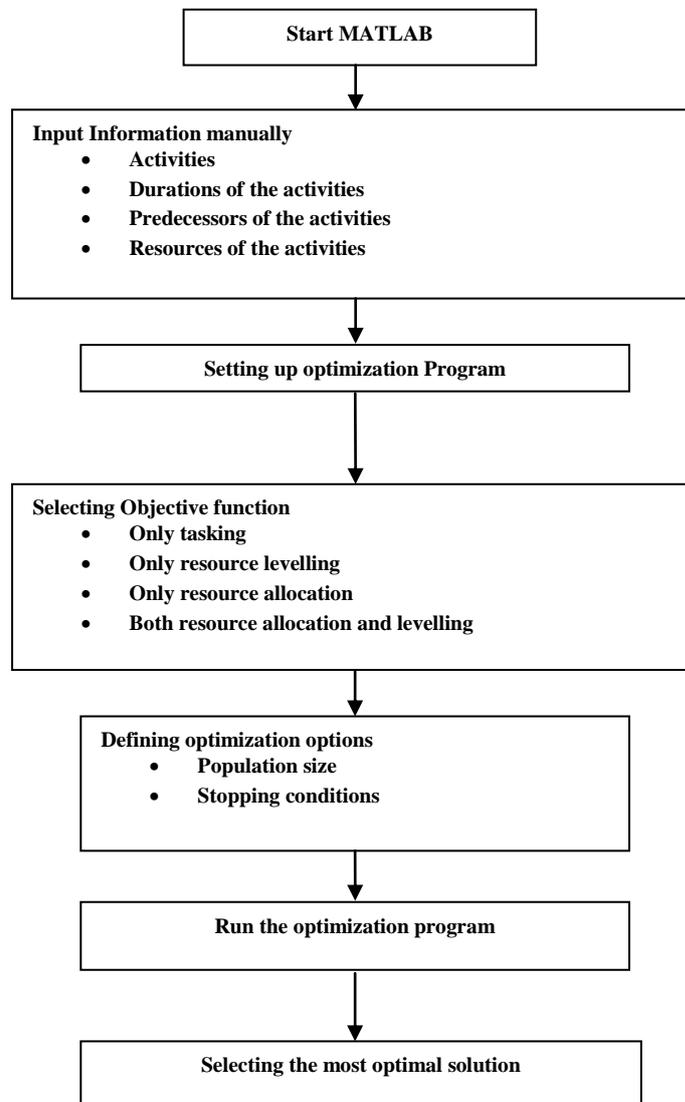


FIGURE 2 Optimization processes of the resource levelling and allocation

## VI. RESULTS

Problem is executed by using many generations. The total project duration before resource allocation and levelling is 32 days as shown in figure.3.

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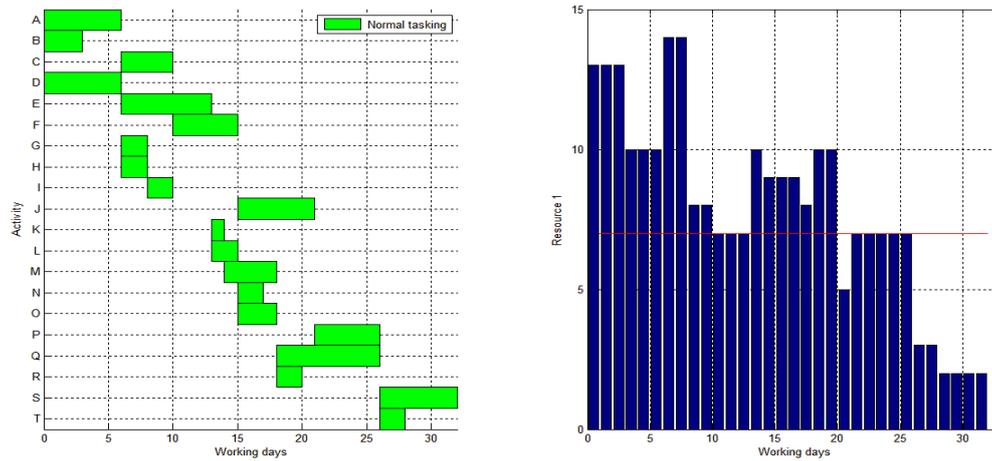


Figure 3 before resource allocation and levelling

In order to satisfy resource limitation constraints, the duration of the project after the resource allocation and levelling is 54 days. as shown in figure 4 After the optimisation of the resource allocation and levelling the model has been considered for the well levelled resource utilisation. Best fitness is obtained in 100 generations.

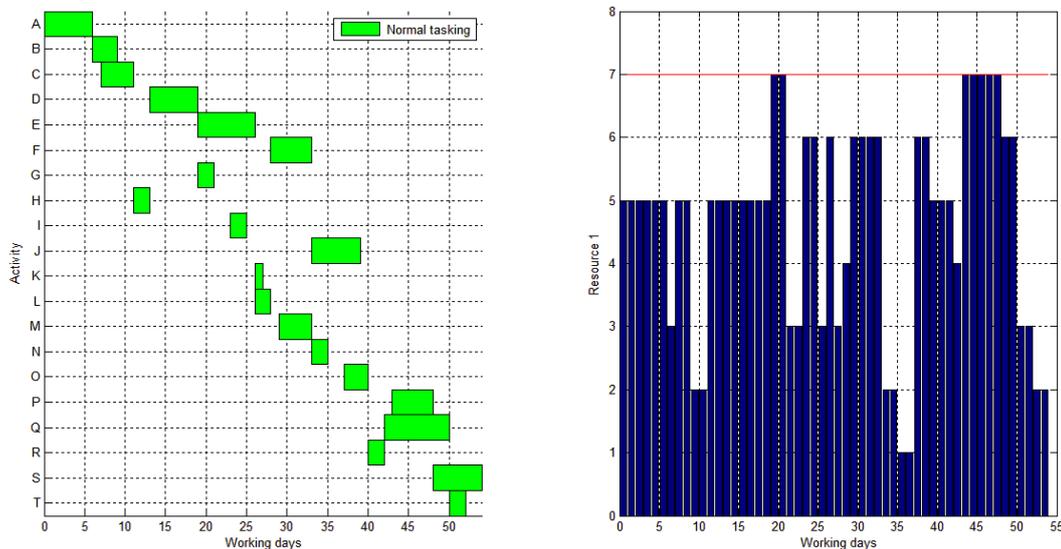


Figure 4 after resource allocation and levelling

## VII. CONCLUSION

An implementation of genetic algorithm developed a model for optimisation of resource allocation and levelling using MATLAB software. The practitioners' software provides powerful capabilities to apply GA for optimisation. It is hoped that implementation of this model justified the efforts spent in proper planning and scheduling as key to effective construction project management and ultimately to actual saving in project time and cost. GA can be utilized in the other areas of project management such as productivity, value engineering etc



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