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STUDY ON APPLICATION OF GENETIC ALGORITHM IN CONSTRUCTION RESOURCE LEVELLING

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ABSTRACT: Resource management ensures that a project is to be completed on time, at cost, and its quality is as previously defined; nevertheless, the scarcity of resources is a usual reason for project delays. Traditional analytical and heuristic approaches are inefficient and inflexible when solving construction resource levelling problems. The proposed algorithm can effectively provide the optimal or near-optimal combination of construction resources by the starting and finishing dates of activities subjected to the objective of resource levelling. In the proposed method the activity to be selected first for shifting is based on the largest value of resource rate. The process is repeated for all the remaining activities for possible shifting of resources by searching the fittest solution by the Genetic Algorithm. The GA procedure searches for optimum results in set of tasks and priorities that produce shorter project duration and better using MS Excel Evolver software.

KEYWORDS: Genetic Algorithm(GA), Resource Levelling, MS Excel Evolver.

1.INTRODUCTION

Since the late 1950s, the Critical Path Method CPM and the Program Evaluation and Review Technique PERT have been intensively used by practitioners for planning and controlling large-scale projects in the construction industry. In a traditional CPM and PERT analysis, every activity is assumed to start as soon as possible. In a real construction project, activities other than those on critical paths may shift along available floating times so as to have more even resource profiles. Resource levelling problems have been studied intensively in the construction and manufacturing industries because of their practical applications. A number of resource levelling models and algorithms have been developed to reduce the level of fluctuations in resource utilization and their negative impact on construction productivity and cost. Available resource levelling models are designed to minimize resource fluctuations by shifting noncritical activities within their available floats to keep the project duration of the original early schedule unchanged.A new approach, employing the use of genetic algorithms GAs., overcomes these drawbacks.

2.GENETIC ALGORITHM

The Genetic algorithm is an adaptive heuristic search method based on population genetics. Genetic algorithm were introduced by John Holland in the early 1970s.Genetic algorithm is a probabilistic search algorithm based on the mechanics of natural selection and natural genetics. Genetic algorithm is started with a set of solutions called population. A solution is represented by a chromosome. The population size is preserved throughout each generation. At each generation, fitness of each chromosome is evaluated, and then chromosomes for the next generation are probabilistically selected according to their fitness values.

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A genetic algorithm is a search technique used in computing to find exact or approximate solutions to optimization and search problems. Genetic algorithms are categorized as global search heuristics. Genetic algorithms are a particular class of evolutionary algorithms (EA) that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover. Genetic algorithms fall under the heading of evolutionary algorithm. Evolutionary algorithms are used to solve problems that do not already have a well defined efficient solution. Genetic algorithm have been used to solve optimization problems (scheduling, shortest path, etc), and in modelling systems where randomness is involved (e.g. the stock market).

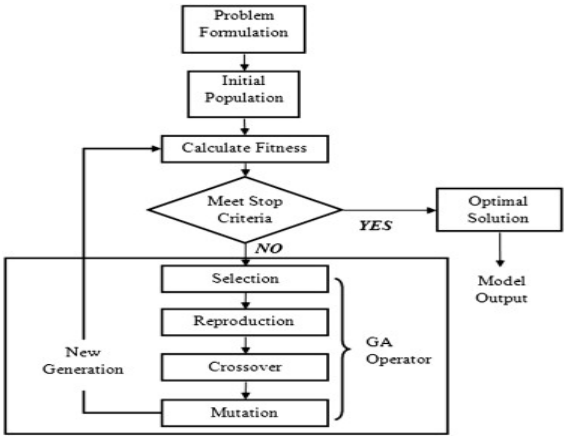

Figure 2.1 Flowchart Showing Genetic Algorithm Process

3.0 RESOURCES

Resources may be renewable or non-renewable. Renewable resources are available each period without being depleted. Examples of renewable resources include labour and many types of equipment. Non-renewable resources are depleted as they are used. Examples of non-renewable resources include capital and raw materials. Note that the distinction between renewable and non-renewable resources may be tenuous. In some cases, renewable resources may become non-renewable Resources, in others, non-renewable resources may be considered renewable.

Resource		Unit
R1	Client	No
R2	Mason	No
R3	Unskilled	No
R4	Crawler	No
R5	Carpenter	No
R6	Bar bender	No
R7	Plumber	No
R8	Electrician	No
R9	Painter	No
R10	Dewatering pump	No
R11	Sand, cum	Cum
R12	Brick	1000 Nos
R13	Steel,kg	kg
R14	Cement, bag (50kg)	Bag
R15	Project manager	No
R16	Site Incharge - Block based	No
R17	Site Engineer	No
R18	Foreman	No
R19	Supervisor	No

Figure 3.0 Resources

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3.1 Resource Levelling

Resource levelling is a technique in project management that overlooks resource allocation and resolves possible conflict arising from over-allocation. When project managers undertake a project, they need to plan their resources accordingly .This will benefit the organization without having to face conflicts and not being able to deliver on time. Resource levelling is considered one of the key elements to resource management in the organization.

An organization starts to face problems if resources are not allocated properly i.e., some resource may be over-allocated whilst others will be under-allocated. Both will bring about a financial risk to the organization.

3.2 Resource Levelling By Genetic Algorithm

Resource levelling is needed in construction to avoid the difficulties associated with the large variations in resource usage. There are two basic categories of scheduling resources: fixed-limits resource scheduling and resource levelling. The fixed-limits resource scheduling arises when there are definite limitations on the amount of resources available. The scheduling objective is to extend the project duration as little as possible beyond the original critical path length such that the resource constraints are met. In this process, both critical and noncritical activities are shifted. Many heuristic and optimization methods have been developed for fixed-limits resource scheduling and can be found in the preceding references.

The resource levelling problem arises when there are sufficient resources available and it is necessary to reduce the fluctuations in the pattern of resource usage. These fluctuations are very undesirable because they often present labour, utilization, and financial difficulties for the contractor. The scheduling objective is to make the resource requirements as uniform as possible, or in some cases to make them match desirable non uniform resource levels. In resource levelling, there are no resource limits and the process is accomplished by shifting only the non critical activities within their available floats; the project duration of the original critical path remains fixed. For the optimization of resources, genetic algorithm is used , by the operators of GA to find the fittest value in the non critical activities by changing their schedules and combining the resource usage in activities. The method of solving resource constraint problem using the software Evolver which uses GA optimization technique is presented in this paper. Evolver is a powerful software solution for optimization problems which utilizes genetic algorithm methodology. Evolver includes an Excel Add-In which allows the user to run for an optimization problem from Microsoft Excel, as well as a Dynamic Link Library of genetic algorithm functions that may be called from programming languages such as Microsoft Visual Basic or C.

EVOLVER'S EXCEL INTERFACE

Creating a problem solving model in Evolver requires that the relevant data is entered into a Microsoft Excel spreadsheet and specify problem solving parameters. Evolver actually solves the problem by allowing the less fit individuals in the population to die, and selectively breeding the fittest individuals. The process is called selection, as in selection of the fittest. Two individuals are taken and mated (crossover), the offspring of the mated pair will receive some of the characteristics of the mother and some of the father. In nature, offspring often have some slight abnormalities, called mutations. Usually, these mutations are disabling and inhibit the ability of the offspring to survive, but once in a while, they improve the fitness of the individual. Evolver occasionally causes mutations to occur. As Evolver mates fit individuals and mutates some, the population undergoes a generation change. The population will then consist of offspring plus a few of the older individuals which Evolver allows to survive to the next generation. These are the most fit in the population, and we will want to keep them breeding .After dozens or

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even hundreds of "generations," a population eventually emerges wherein the individuals will solve the problem very well. In fact, the fit individual will be an optimum or close to optimum solution.

4. RESULT AND DISCUSSION

Analyzing the quality of resource constrained scheduling of project management software, by evaluating two widely used software packages , Primavera and Microsoft Project 2007. Furthermore, the paper compares the results with the previous versions of these software packages, e.g. Primavera Project Planner, Microsoft Project. Project management software packages usually use priority rule-based heuristic algorithms for the resource levelling, but they donot offer other information about the details of the algorithm. For the comparison of results with the MS Excel Evolver for finding the better optimum solution with the various generations of results are compared and concluded.

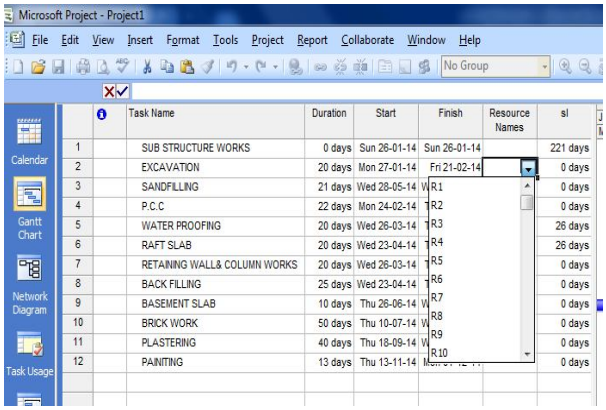

Figure 4.1 Resource Allocating to the Required Activities

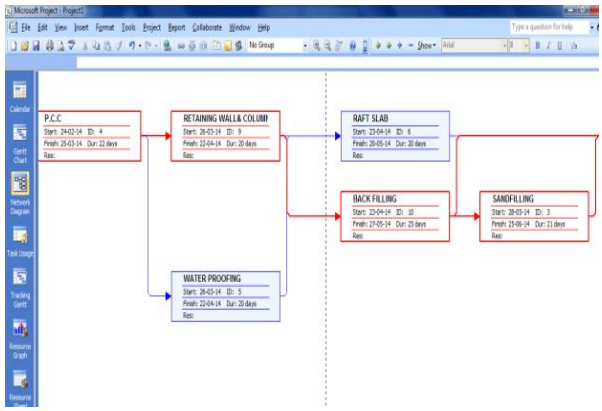

Figure 4.2 Shifting of Non Critical Activity Resources by Their Floats

4.1 Evolver Solution

Problem is executed by using many generations. The converging result obtained was T = 760 days by applying resource constraints. Best fitness is obtained in 200 generations.

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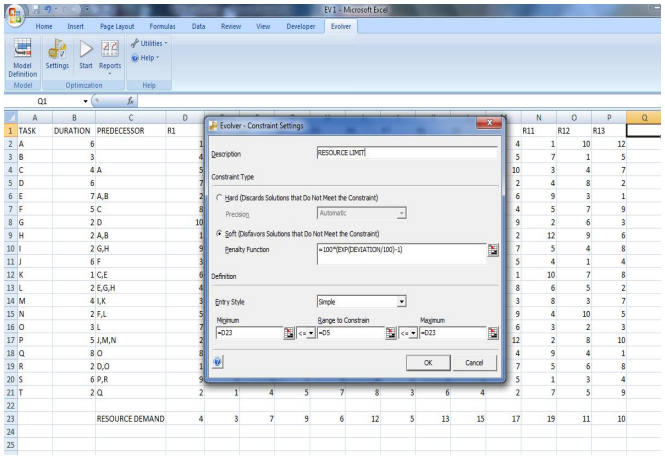

Figure 4.3 Constraints setting in MS Excel Evolver

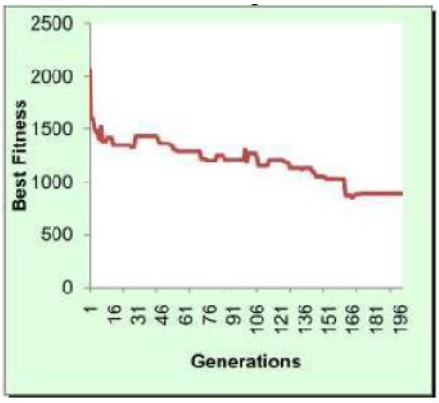

Figure 4.4 Evolver solution

5.CONCLUSION

CPM is inappropriate for scheduling resource constrained projects, and project managers should not rely only on this method when dealing with limited resources. Project management software packages should incorporate other more efficient methods for resource constrained scheduling and should try to illuminate some drawbacks. An implementation of the GA developed model for project scheduling of resources for levelled use has resulted in optimized output with reduced cost. A real time project solved using shows that best converging result can be obtained. By this optimization software shows the best result in problem solving in real time.

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