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SCHEDULE AND RESOURCE OPTIMIZATION USING PARTICLE SWARM OPTIMIZATION

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Abstract-Scheduling is the process of arranging the activities in a logical order to achieve project completion.Each task is allotted with resources and is scheduled to complete the project within time.The main objective of the paper is to find the optimum schedule for the timely completion of the project using Primavera and also the optimum utilization of resources using Particle Swarm Optimization. Particle Swarm Optimization (PSO) is a relatively recent heuristic search method whose mechanics are inspired by the swarming or collaborative behavior of biological populations.In this paper, Resource scheduling using Primavera and Particle Swarm Optimisation (PSO) has been attempted. A comparison is made between Primavera and Particle Swarm Optimization(PSO) after solving the scheduling problem. The main purposes of this study is to incorporate both the duration time and cost into the objective function and to develop an efficient heuristic search scheduling rule using a PSO algorithm.The results shows that PSO algorithm is feasible to apply construction schedule optimization.

Keywords- Scheduling, Resources, Particle Swarm Optimisation (PSO0,Genetic Algorithm(GA),Critical Path Method (CPM), Work Breakdown Structure(WBS), Primavera.

I. INTRODUCTION

Project scheduling is a process whereby the tasks needed to be performed in order to attain project completion are arranged in a logical order. It is a projected timetable of construction operations that will serve as the principle guideline for project execution. In addition to assigning dates to project activities, project scheduling is intended to match the resources of equipment, materials and labour with project work tasks over time. This type of scheduling is complete by way of bar charts; either by hand, or more likely computer generated. In particular, the critical path method of scheduling is commonly required by Owners.

As scheduling is very vital in the manufacturing industries, researchers have always shown interest in optimizing the mathematical problem. Esra Koyuncu and Rızvan Erol(2015) proposed considered the RCS of product development projects in which activity overlapping is processed to shorten project duration. The proposed algorithm can give optimal or near optimal schedule with the objective of minimum project duration. Liwen You(2014) introduced the invention, development and improvement of particle swarm optimization.It then improves the PSO with the crossover and variation in genetic algorithm and the choosing and memory in immune, at last forms the improved PSO. Zhou et al(2013) has focused on minimizing project time and cost so as to achieve maximum profit. Minimization of time and cost will have an influence on the project quality and risk, which are even more crucial for the successful completion of a construction project. Hong Zhang et al(2012) proposed the solution to the RCSP problems with the objective of minimising duration .In consideration of the two particle representations (Priority based and Permutation based representations). FatemehAzimi et al(2012) proposed that multi-mode resource constraint project scheduling with the objectives of maximization the net present value and minimization of makespan. It used one evolutionary algorithm MOPSO for solving this problem. Nagaraju and Sivakonda Reddy (2012) revealed thatThe resource management is essential for a construction project to succeed in fulfilling its project objectives. Allocation of resources for activities is necessary in construction domain to complete the project within the scheduled time. Resource leveling is needed in construction projects to avoid the difficulties associated with the large variations in resource usage.

Fang Xu, Xin Zhanhong (2012) presented a new approach for construction resource optimization .This paper have been showed the PSO can be applied to more general problems without great difficulty. Mehdi Tavakolan(2011) presents the comprehensive model of Time-Cost-Resource Optimization in terms of obtaining the shortest duration, the least project cost, and the least resource moments in the least time and the fewest number of iterations.According to the project size, It evaluate the significant parameters of each algorithm to obtain the optimal project schedule solutions. Emad Elbeltagia et al(2005) revealed that the comparative study of five evolutionary-based search methods (GA, MA, PSO, ACO, and SFL) were presented. A brief description of each method is presented along with a pseudo code to facilitate their implementation.Among five methods, The PSO method was found to perform better than other algorithms in terms of success rate and solution quality, processing time. Hong Zhang et al (2005) revealed that the theory of PSO has been proposed for solving the RCPSP with the objective of minimizing project duration.The permutation-based sequence of the activities is described by the multidimensional particle.The proposed PSO shows some advantages over GA, such as "one-way" sharing of the local best and the global best experiences during the search process and easy adjusting of a few parameters for satisfied results. Natasa Prascevic, Zivojin Prascevic(2005) proposed that the particle swarm optimization method can successfully be used for optimising realization of construction projects.This paper have adopted this method for solving these problems, taking into account project costs, activity durations, and activity correlations in the critical path diagram.

Comparing the above papers, this paper is unique in the sense that it considers multiple processing lines and CS, PSO and hybrid CS-PSO is used to schedule the jobs in multiple processing lines.

This paper is organized as follows. Scheduling is discussed in 2.Primavera Project planner is discussed in section 3.Particle Swarm Optimization algorithm is discussed in Section 4. The methodology of this paper is discussed in section 5. Section 6 contains the performance comparison, results and discussion. The conclusion of this paper is given in section 7.

II. SCHEDULING

Project scheduling is a process whereby the tasks needed to be performed in order to achieve project completion are arranged in a logical order. It is a projected timetable of construction operations that will serve as the principle guideline for project execution. In addition to assigning dates to project activities, project scheduling is intended to match the resources of equipment, materials and labour with project work tasks over time. This type of scheduling is done by way of bar charts; either by hand, or more likely computer generated. In particular, the critical path method of scheduling is commonly required by owners.

The project schedule is a calendar that links the tasks to be done with the resources that will do them.Developing network plan from these activities and separate calendar is created for the project scheduling. The calendar used in the project is of 6 days in a week and 10 hours per day.

The network shows the sequences and interdependence of activities, their time duration and their earliest start time and latest completion time. The start time and commencement of activities are given in the Primavera. After scheduling the project, it is possible to determine commencement and termination date of each activity.

First the Work Break Structure(WBS) is fed into the software. The activity and their duration are given as inputs in the Primavera Project Planner.The relationship between the activities are given using relationship option. Before scheduling, starting date of the project is given. After running,the project total duration arrived is given. It is the determination of the timing and sequence of operations in the project and to gives the overall completion time.

The main purpose of the scheduling is to optimize the resources in which it is required for the completion of the project.

III. PRIMAVERA PROJECT PLANNER

Project planning management tool developed by primavera system inc.in 1983.Primavera project planner(P3) is the first software released by primavera. The latest version is P6.8.Primavera is designed to handle large-scale, highly sophisticated and multifaceted projects. The modules are Project Management, Methodology Management & My Primavera.

Primavera P6 offers an easy-to-use approach to project planning with an intuitive interface that makes project planning and control easy,without sacrificing the powerful sophistication of high-end project-management software that you expect from primavera.The Primavera integrated construction management solution provides

- Role-based dashboards
- Productivity-based
- Forecasts
- Easy-to-read graphical trends custom reports

Primavera is an integrated product that goes far beyond scheduling providing you with advanced collaboration tools, action alerts and centralized project information.The information from WBS and logic Network can be input into a software package such as primavera 6 to provide a detailed plan. Enter the tasks, predecessors, resources and time estimates into the software. Once entered, the software will create the charts and graphs automatically.Primavera P6 helps identify and mitigate risks in the course of planning, managing, and completing a project. Primavera P6 allows all involved in a project to carefully monitor resource availability and adjust such resources to meet project demands. Primavera helps to determine the schedule of the activities and relationship between the activities. Scheduling also provides comparison of actual progress against plan and help identify deviations from plan. Scheduling also enables early corrective actions and adjustments to plan.

IV. PARTICLE SWARM OPTIMZATION

Particle swarm optimization (PSO) is a population based heuristic global optimization method and it was developed by Kennedy and Eberhart in 1995. It is developed from swarm intelligence and is based on the research of collective behaviour of bird and fish. When the birds are searching for food, they are either in different direction or at the same direction before they are identifying the place where the food is present. While the birds are searching for food from one place to another, one bird among the group can smell the place where the food is available and having the better food resource information. This information will be conveyed to all other birds and based on the quality of the information all other birds will update their direction and velocity towards the bird which is having better food resource information. As far as particle swam optimization algorithm is concerned, all the possible solutions are considered as birds which searching for a food and good information is equal to the optimum solution. The most optimum solution can be finding out in PSO algorithm by the cooperation of each individual particle. PSO consists of a swarm of particles moving in an n-dimensional problem with n-solutions. Every particle ‘i’ at the time‘t’ has the following characteristics:

- X_i,t,V_i,t are the position and the velocity vectors
- P_i,t is the small memory storing its own best position
- G_i,t is the global best position

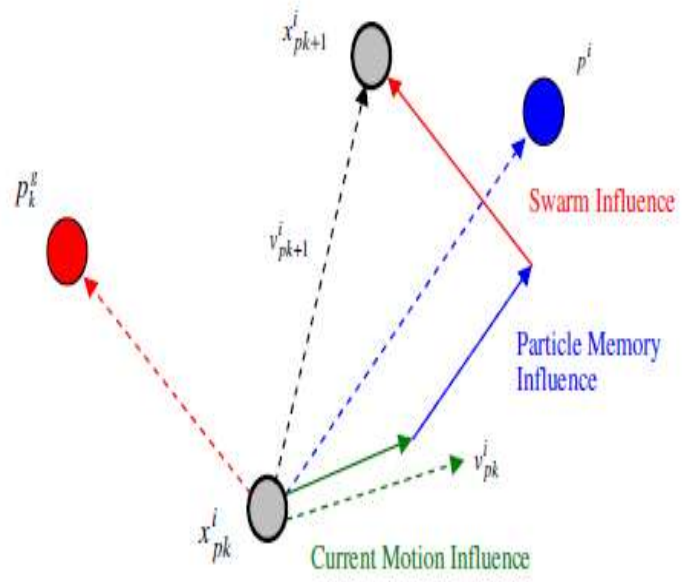
At each time step t, the velocity is updated and the particle is moved to a new position. This new position is calculated as the sum of previous position and the new velocity

$$X_{i,t+1} = X_{i,t} + V_{i,t} + 1$$

The update of the velocity is determined with the following relation

$$V_{i,t+1} = \omega . V_{i,t} - c_1 . r_2 . (P_{i,t} - X_{i,t}) + c_2 . r_3 . (G_{i,t} - X_{i,t})$$

Where ω is the inertia weight that controls the impact of the previous velocity on the current velocity by balancing of exploration and exploitation characteristic of an algorithm.



Each particle keeps track of its coordinates in the problem space which are associated with the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the neighbors of the particle. This location is called lbest. when a particle takes all the population as its topological neighbors, the best value is a global best and is called gbest.

Particle Swarm Optimization (PSO) is a relatively recent heuristic search method that is based on the idea of collaborative behavior and swarming in biological populations. PSO is similar to the Genetic Algorithm (GA) in the sense that they are both population-based search approaches and that they both depend on information sharing among their population members to enhance their search processes using a combination of deterministic and probabilistic rules. Conversely, the GA is a well established algorithm with many versions and applications.

Particle swam optimization is a new heuristic optimization method based on swarm intelligence. Compared with the other algorithms, the method is very simple, easily completed and it needs fewer parameters, which made it fully developed. However, the research on the PSO is still at the beginning, a lot of problems are to be resolved. PSO has shown its fast search speed in many complicated optimization and search problems.

The main objective is to determine the optimum duration and cost by various iterations .The PSO algorithm is designed by MATLAB Programming or C Programming.

V. METHODOLOGY

- Literature collection for the project.
- Problem definition and objective definition.
- Study on different optimization techniques.i.e.
- Genetic Algorithm(GA),Particle Swarm optimization(PSO) techniques, Artificial Neural Network(ANN).
- Selection of optimization techniques and design project.
- Identification of the activities and resources allocation for the activities.
- Scheduling the activities using primavera project planner.
- Optimization of resources using Particle Swarm optimization.
- Comparison between Primavera and PSO.
- Results and conclusion.

VI. RESULTS AND DISCUSSIONS

The Scheduling using Primavera and PSO are developed in this paper.The PSO algorithm is designed in MATLAB programming and are made to run for different iterations.The algorithm is made to run for iterations and the results are compared to get optimal solution.

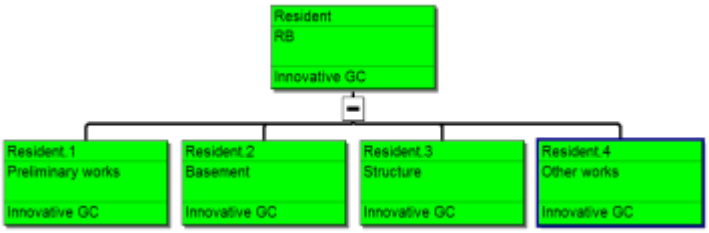
Results of Primavera :

Table Scheduling of the project

Project	Duration	Start date	Finish date
Residential building	277	2nd November 2015	25 July 2016

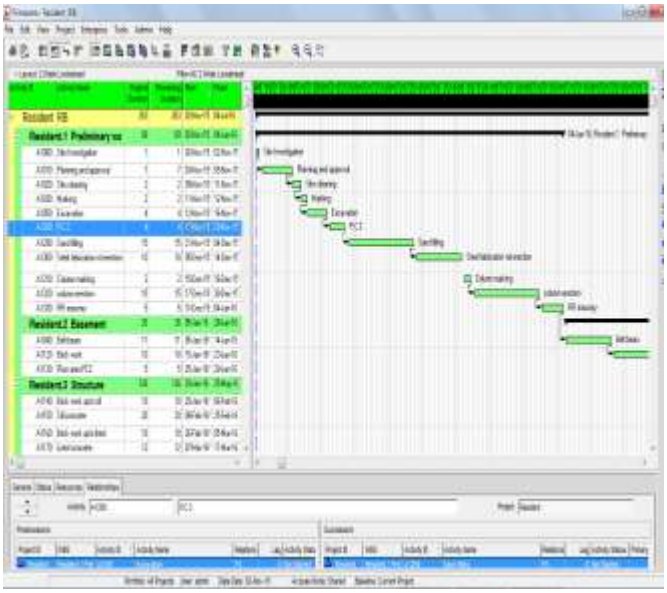
The total number of activities = 56

The figure shows the scheduling of the project with activities and its duration using Primavera Project Planner**.**



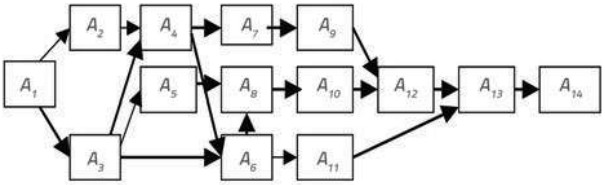
This figure represents the major activities of the project.It contains the sub activities of the project.

This figure represents the Work Breakdown Structure.It contains the activity of the project and its project status.



This figure represents the sequence of the activities and its relationship.It contains the start and finish date of the activities.

Results of PSO:



Details	Primavera	PSO
Duration	277	220
Cost of the project	35,00,000	25,00,000

VII. CONCLUSIONS

Swarm intelligence-based algorithms such as particle swarm optimization are very efficient in solving a wide range of nonlinear optimization problems. The algorithm are implemented successfully for solving the scheduling optimization problem. Results obtained from Primavera and PSO are compared and the performances are analysed. PSO is found to be superior and gives Optimum duration and minimum cost of the project. In the future, this work may be further extended for solving scheduling problems in the construction projects.

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