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Design of System for Controlling, Scheduling and Monitoring of Construction Project using System Software

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Abstract Construction monitoring, controlling and scheduling is one of the important tool in a construction project. Every construction project involve with a lot of activities which need to be planned, monitored, controlled and scheduled properly to ensure the completion of the project. These project management techniques of planning, scheduling and controlling are used to complete the project within the stipulated time, scope, quality and cost. These techniques can be applied to all types of projects. Resource allocation and levelling are among the top challenges in project management, due to the complexity of projects. The main objective of this project is to optimize the resource schedule of construction project activities in order to minimize the total duration of the project, maximization of net present value, or minimization of average tardiness subjected to both precedence and resources constraints using an optimization technique called Ant Colony Optimizing Algorithm (ACO). This work describes an algorithm approach to Resource Constraint Project Scheduling Problems (RCPSP) in construction industry. The study on the optimization technique that is genetic algorithm and its terminology, operator, parameter used is clearly depicted. The modern approach of using ant colony algorithm technique to solve the Resource Constraint Project Scheduling Problems (RCPSP) problem for a construction project with constraints and to find the best optimal solution by overcoming the drawbacks in other optimization technique. The algorithm adapts to dynamic factors such as changes to the project plan or disturbances in the schedule execution. The ACO procedure then searches for an optimum set of tasks and priorities that produce shorter project duration and better-levelled resource profiles.
Keywords *Project Management; Scheduling of Works; Management of Work Task*

1. Introduction

Construction is a whole wide developed industry at present scenario with new innovation and inspiring technology. Construction is a process where many aspect ratios should be considering from design aspect to environment aspect. To execute the work as per the schedule guidelines proper work

assessment and management is required. Construction project management plays a vital work where it satisfies the client requirement. For the success in construction industries good management is required to be following from the execution work to the resource allocation. Project management can deal with both critical path method and Project Evaluation and Review Technique for project planning process which helps to allocate the duration of individual activity.

2. Objective

The objective of the project is to use optimized resource with constraint in cost. Ant Colony Optimizing Algorithm is the main source for optimizing the scheduled duration and resource cost. The major objective of this management is to concentrates on time, cost and quality. To which Comparison study on primavera, easy plan software and ant colony optimizing technique on basis on both aspect of duration and resources cost.

3. Methodology

In order to optimally utilize resources in a resource constrained project the concept of Ant Colony Optimization Algorithm is to be used. Figure 1 show the steps involved in the process. A computer model that solves Resource-constrained scheduling problems in construction projects and by fixed duration of time by implementing the following steps:

a) Carrying out a survey on the previous research that is related to the different approaches to schedule resource-constrained problems;
b) Studying the ACO approach in order to apply it in the current study;
c) Developing a computer model to optimize the process of scheduling projects under a given resource-constraints using ACO technique;
d) Comparison of the conventional technique with Ant Colony Optimization Algorithm with the chosen the real time project.

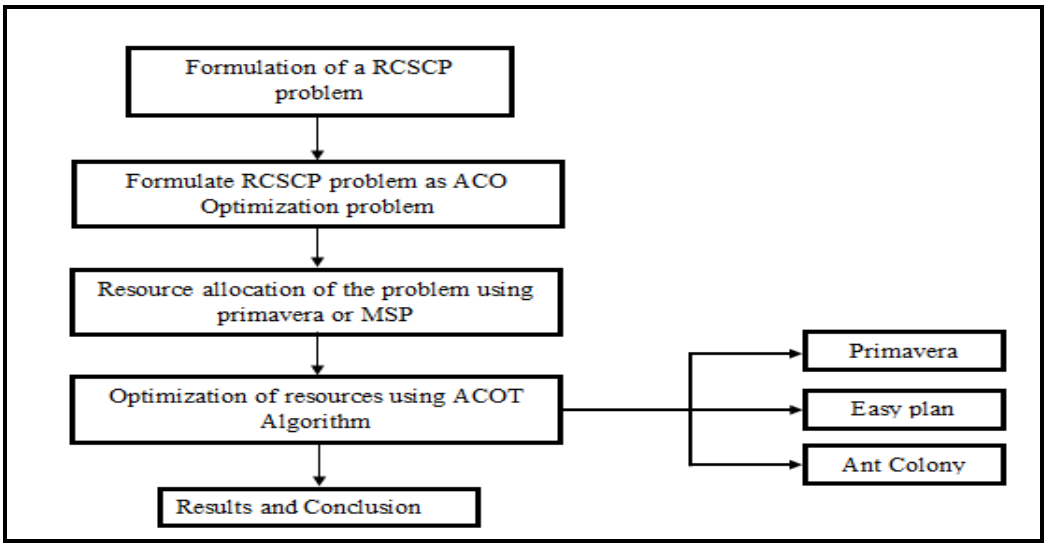

Figure 1: *Methodology*

4. Basic Outline of Ant Colony Optimizing Algorithms

Figure 2 shows the various steps involved in Ant colony optimizing Algorithm process.

A typical implementation of genetic algorithm

1) **[Start]** Generate random time for analysis.
(Suitable solutions for the problem).

2) **[New population]** Create a new population (time) by repeating following steps until the new population is complete.

3) **[Selection]** Select two timing according to their fitness (the better fitness, the bigger chance to be selected). The idea is to choose better timing.

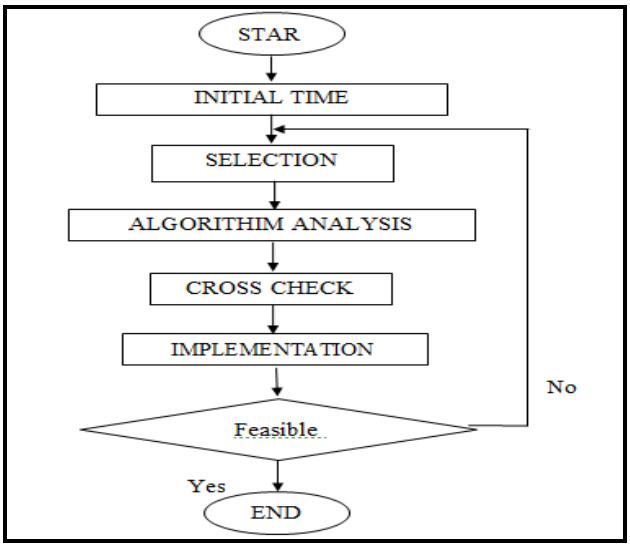

Figure 2: *Steps Involved in Ant Colony Optimizing*

4) **[Crosscheck]** with a crossover probability cross over the time to form a new offspring (time).

5) **[Accepting]** Place new assumption in a new time duration.

6) **[Replace]** Use new generated duration for a further run of algorithm.

7) **[Test]** If the end condition is satisfied, stops, and returns the best solution in current population (time/duration), and

8) **[Loop]** Go to step No. 2.

5. Design of Scheduling System

Every project has unique technique and implementation techniques basis on their requirement accordingly the duration are assumed there are implemented in primavera software as listed below.

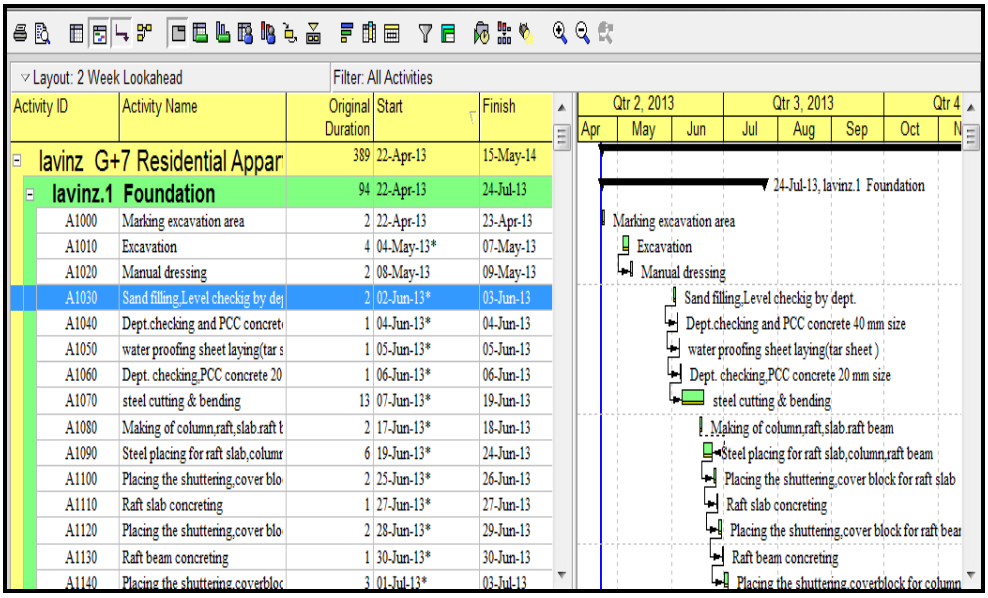

Figure 3: *Primavera Scheduling*

6. Syntax: Algorithm for Scheduling/Duration

Procedure ACO ()

```
While (termination criterion not satisfied)
        schedule activities
        ants generation and activity();
        end schedule activities
end while
end procedure
procedure ants generation and activity()
        while (available resources)

        schedule the creation of a new ant();
        new active ant();
end while
end procedure
procedure new active ant() ant lifecycle
        initialize ant();
        M= update ant memory();
        while (current state = target state)
        A = read local ant-routing table;
        P = compute transition probabilities (A; M; problem constraints);
        next state = apply ant decision policy(P; problem constraints);
        move to next state(next state);
if (step-by-step pheromone update)
        deposit pheromone on the visited arc();
        update ant-routing table();
end if
        M= update internal state();
end while
```

```
        if (online delayed pheromone update)
        evaluate solution();
        deposit pheromone on all visited arcs();
        update ant-routing table();
end if
end procedure
```

Table 1: *Rescheduling Duration*

S. No.	Activity	Predecessors	Duration	Rescheduling using ant optimizing	Manual estimation
1	**5th floor**	**Independent activity**	**24 days**	**17**	**-**
2	column	Independent activity	7 days	4	6
3	floor beam and roof slab	2	17 days	14	15
4	staircase	Independent activity	9 days	6	8
5	OTS	Independent activity	8 days	4	7
6	4th floor brick work	Independent activity	8 days	6	6 1/2
7	**6th floor**	**1**	**30 days**	**36**	-
8	Column	Independent activity	9 days	5	7
9	Floor beam & roof slab	8	19 days	14	17
10	Staircase	Independent activity	8 days	6	7
11	OTS	Independent activity	9 days	4	7
12	5th floor brick work	Independent activity	11 days	7	9
13	**7th floor**	**7**	**24 days**	**34**	-
14	Column	Independent activity	7 days	4	6
15	Floor beam & roof slab	Independent activity	18 days	13	16
16	Staircase	Independent activity	11 days	7	9
17	OTS	Independent activity	9 days	4	8
18	6th floor brick work	Independent activity	9 days	6	7
19	8th floor brick work & weathering course	13	4 days	2	3
20	Plumbing	Independent activity	45 days	36	42
21	Doors and Windows fixing	Independent activity	50 days	42	46
22	Internal plastering	Independent	58 days	49	52
23	External plastering	22	25 days	21	23 ½
24	water tank & balcony work	Independent activity	20 days	14	16
25	Finishing	Independent activity	31 days	20	26

7. Resource Algorithms

Resource allocation for the delay work is been analyzed by using ant colony optimizing algorithm and the values are listed in Table

Input: Activity

Output: Optimal allocation of Resources

For i= n to m (Resources size) do
Assume value = x (generate valid solution)
End
Curr alloc = min (assume value)
For i = n to m (Resources size) do
If i < 15% of manual estimation
Cost perc =15% (increase)
Else
If i < 25% of manual estimation
Cost perc =30 % (increase)
Else
If i < 40% of manual estimation
Cost perc =50 % (increase)
Else
End

Table 2: *Resources Allocation*

S. No.	Activity	Description	Duration (days)	Required Resources/day		
				R1	R2	R3
1		**5th floor**				
2	A	column	4	4	16	3
3	B	floor beam and roof slab	14	6	17	5
4	C	staircase	6	2	5	2
5	D	OTS	4	2	6	
6	E	4th floor brick work	6	4	11	
7		**6th floor**				
8	F	Column	5	4	15	3
9	G	Floor beam & roof slab	14	6	15	5
10	H	Staircase	6	2	6	2
11	I	OTS	4	2	6	
12	J	5th floor brick work	7	4	13	
13		**7th floor**				
14	K	Column	4	4	15	3
15	L	Floor beam & roof slab	13	6	16	5
16	M	Staircase	7	2	7	2
17	N	OTS	4	2	6	
18	O	6th floor brick work	6	4	11	
19	P	8th floor brick work & weathering course	2		10	
20	Q	Plumbing	36		14	
21	R	Doors and Windows fixing	42	4	15	
22	S	Internal plastering	49		16	

23	T	External plastering	21	14
24	U	water tank & balcony work	14	15
25	V	Finishing	20	15

8. Easy Plan

Easy Plan is program for Integrated Project Management. A simple but powerful spreadsheet program for integrated project management.

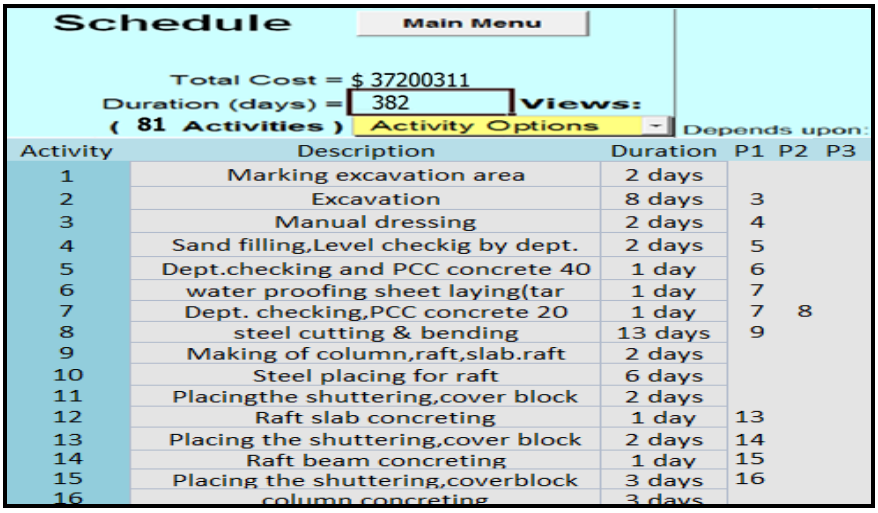

Figure 4: *Easy Plan Solution*

The converging result obtained was **T = 382 days** using Easy Plan.

9. Resource Limit

Resource limit for the whole project and actual usage of resources are listed below,

Table 3: *Resource Limit for Sample Problem*

Resource	Limit		Actual usage (Nos)
	Min (Nos)	Max (Nos)	
R1	50	65	58
R2	280	310	294
R3	60	75	67

10. Start Date and Duration Limit

Activity start date and code is mentioned and duration range is also given below,

Table 4: *Duration Limit and Start Date Sample Problem*

Activity	Min. Range(days)	Duration (days)	Max. Range(days)
column	4	4	6
floor beam and roof slab	14	14	15
staircase	6	6	8
OTS	4	4	7

4th floor brick work	6	6	6 1/2
Column	5	5	7
Floor beam & roof slab	14	14	17
Staircase	6	6	7
OTS	4	4	7
5th floor brick work	7	7	9
Column	4	4	6
Floor beam & roof slab	13	13	16
Staircase	7	7	9
OTS	4	4	8
6th floor brick work	6	6	7
8th floor brick work	2	2	3
Plumbing	36	36	42
Doors and Windows	42	42	46
Internal plastering	49	49	52
External plastering	21	21	23 ½
water tank	14	14	16
Finishing	20	20	26

Optimised duration obtained in Ant colony optimizing = **379 days.**

11. Comparison of Results

Implementation of all the activities, duration and resources in Primavera, Easy Plan, and Ant Colony Technique obtains the following results,

Table 5: *Comparison of Results*

	Primavera	Easy Plan	Ant colony
Optimized duration, (days)	389	382	379
R1, (Nos)	175	145	140
Cost, (Rs)	122000	115000	108000
R2, (Nos)	360	300	294
Cost, (Rs)	244000	210000	197600
R3, (Nos)	165	135	125
Cost, (Rs)	113000	110000	99000
Net Project Cost, (Rs)	**479000**	**435000**	**404600**

13. Discussion

- Studies should be done to enlarge the type of relationships between activities that the program can solve other than finish to start relationships.
- In practical projects, the activity does not necessary has a constant rate of resources over his total duration. Actual resource usage must be taken in consideration in future researches.
- Should integrate the efforts toward an integrated program for optimizing scheduling that optimize time, resources, costs and other measurements of project management performance.

14. Conclusions

Ant Colony Optimizing algorithms are conceptually simple and well-suited to problems with multi constraint problem. Although the basic ideas are straightforward, there is actually a great deal of work to implement algorithms on real problems with large search spaces. An implementation of the ACO

developed model for resource-constrained project scheduling has resulted in optimized output with reduced cost. A real time project is solved using this optimization software shows that best converging result can be obtained by fixing the time as constant.

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