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Using the WinQSB Software in Critical Path Analysis

In the present paper will be appealed sub modules from the PERT/CPM module of WinQSB software, adequate to solve the scheduling problems.

Keywords: *CPM, PERT, critical path, normal duration, crash duration*

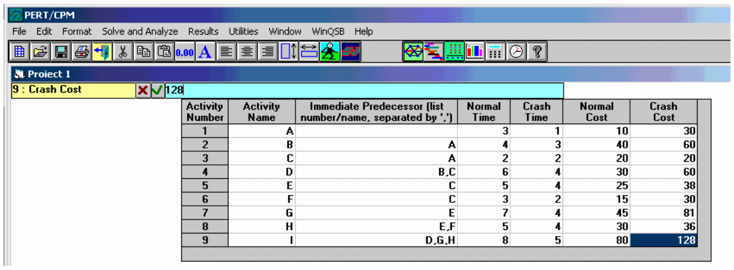
1. Introduction

PERT/CPM Module realize activities or operation scheduling using the CPM method (Critical Path Method) or PERT (Program Evaluation and Review Technique) to analyze the critical path.

2. CPM Method.

In order to obtain a new product, an enterprise must realize a project containing 9 activities (figure 1), marked from A to I. The activities durations are in weeks and the costs in thousands $.

It has to be determined the minimal duration of the project in the modality that all activities to be completed.



Activity Number	Activity Name	Immediate Predecessor (list number/name, separated by ',')	Normal Time	Crash Time	Normal Cost	Crash Cost
1	A		3	1	10	30
2	B	A	4	3	40	60
3	C	A	2	2	20	20
4	D	B,C	6	4	30	60
5	E	C	5	4	25	38
6	F	C	3	2	15	30
7	G	E	7	4	45	81
8	H	E,F	5	4	30	36
9	I	D,G,H	8	5	80	128

Figure 1. Problem Data for CPM method

2.1. Solve the problem using normal durations

The results are printed in two forms: table (figure 2) and graphic (figure 3).

From figure 2, it can be observed that the project can be finalized in 25 weeks, the cost being 295 thousands $ and exists only one critical path with a cost of 180 thousands $.

07-10-2008 16:45:46	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	3	0	3	0	3	0
2	B	no	4	3	7	7	11	4
3	C	Yes	2	3	5	3	5	0
4	D	no	6	7	13	11	17	4
5	E	Yes	5	5	10	5	10	0
6	F	no	3	5	8	9	12	4
7	G	Yes	7	10	17	10	17	0
8	H	no	5	10	15	12	17	2
9	I	Yes	8	17	25	17	25	0
	Project	Completion	Time	=	25	weeks		
	Total	Cost of	Project	=	$295	(Cost on	CP =	$180)
	Number of	Critical	Path(s)	=	1			

Figure 2. Results table

The software builds itself the afferent problem graph, presented in figure 3. The critical path is marked with red color.

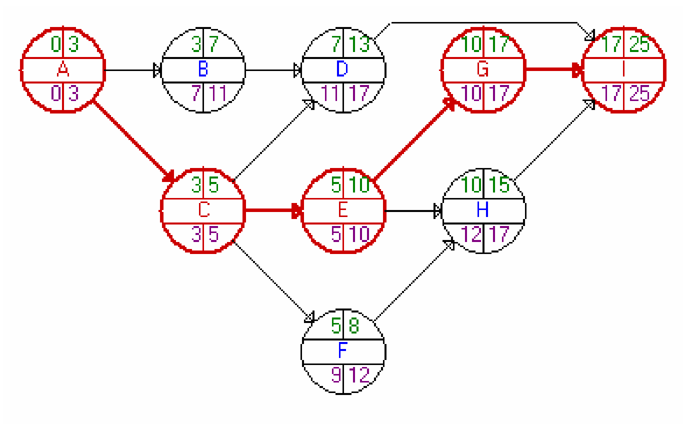


Figure 3. The problem's graph

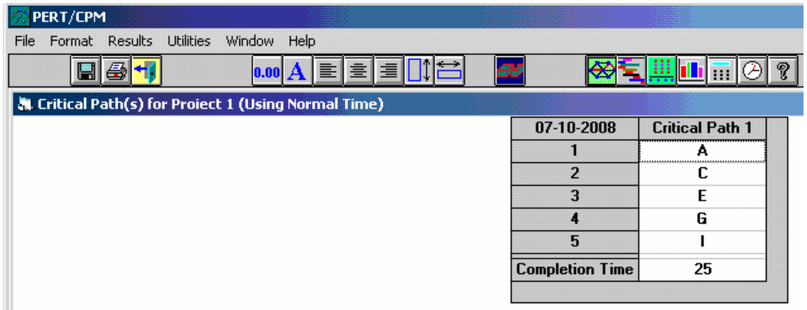


Figure 4. Critical path activities

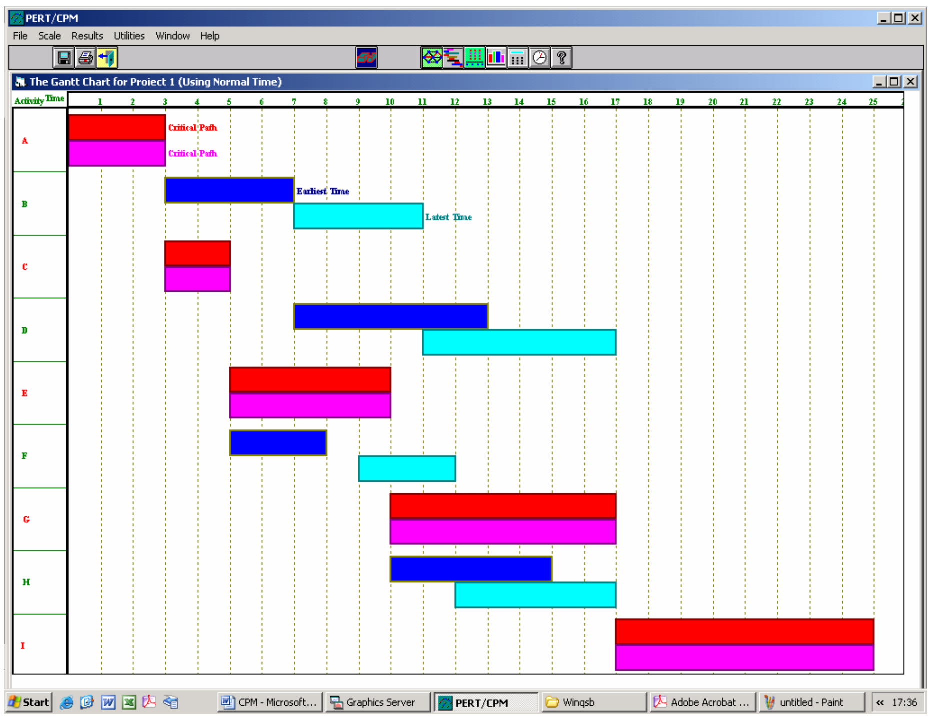


Figure 5. Gantt associated graph for duration of 25 weeks

The Module permit to realize an analysis of the involved costs, provided also in two forms: table or graphic (figure 6).

PERT/Cost Analysis for Project 1 (Using Normal Time)

07-10-2008	Project Time in week	Cost Schedule Based on ES	Cost Schedule Based on LS	Total Cost Based on ES	Total Cost Based on LS
1	1	0,33 lei	0,33 lei	0,33 lei	0,33 lei
2	2	0,33 lei	0,33 lei	0,67 lei	0,67 lei
3	3	0,33 lei	0,33 lei	$1	$1
4	4	$2	$1	$3	$2
5	5	$2	$1	$5	$3
6	6	$2	0,50 lei	$7	3,50 lei
7	7	$2	0,50 lei	$9	$4
8	8	1,50 lei	1,50 lei	10,50 lei	5,50 lei
9	9	$1	1,50 lei	11,50 lei	$7
10	10	$1	$2	12,50 lei	$9
11	11	1,74 lei	2,14 lei	14,24 lei	11,14 lei
12	12	1,74 lei	1,64 lei	15,99 lei	12,79 lei
13	13	1,74 lei	1,74 lei	17,73 lei	14,53 lei
14	14	1,24 lei	1,74 lei	18,97 lei	16,27 lei
15	15	1,24 lei	1,74 lei	20,21 lei	18,01 lei
16	16	0,64 lei	1,74 lei	20,86 lei	19,76 lei
17	17	0,64 lei	1,74 lei	21,50 lei	21,50 lei
18	18	$1	$1	22,50 lei	22,50 lei
19	19	$1	$1	23,50 lei	23,50 lei
20	20	$1	$1	24,50 lei	24,50 lei
21	21	$1	$1	25,50 lei	25,50 lei
22	22	$1	$1	26,50 lei	26,50 lei
23	23	$1	$1	27,50 lei	27,50 lei
24	24	$1	$1	28,50 lei	28,50 lei
25	25	$1	$1	29,50 lei	29,50 lei

Figure 6. Week and total costs planning, based on earlier or latest times

2.2. Solve the problem using *CRASH* durations

In figure 7 are presented the results in table form and in figure 8, in graphical form.

Activity Analysis for Project 1 (Using Crash Time)

07-10-2008 16:46:00	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	1	0	1	0	1	0
2	B	no	3	1	4	4	7	3
3	C	Yes	2	1	3	1	3	0
4	D	no	4	4	8	7	11	3
5	E	Yes	4	3	7	3	7	0
6	F	no	2	3	5	5	7	2
7	G	Yes	4	7	11	7	11	0
8	H	Yes	4	7	11	7	11	0
9	I	Yes	5	11	16	11	16	0
	Project	Completion	Time	=	16	weeks		
	Total	Cost of	Project	=	$483	(Cost on	CP =	$333)
	Number of	Critical	Path(s)	=	2			

Figure 7. Result's table

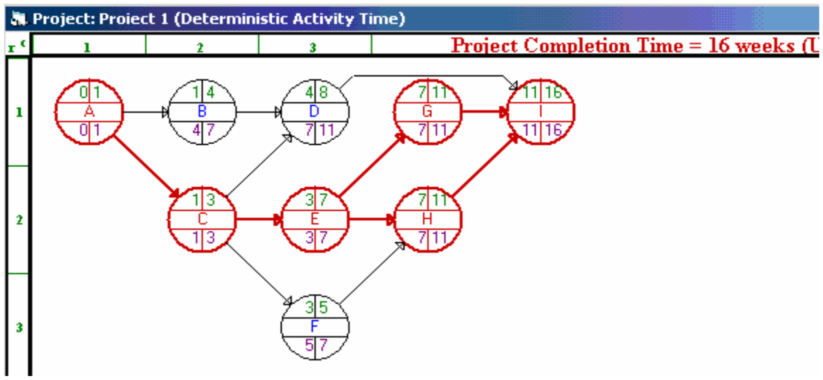


Figure 8. Results on graphical form

Critical Path(s) for Proiect 1 (Using Crash Time)

07-10-2008	Critical Path 1	Critical Path 2
1	A	A
2	C	C
3	E	E
4	G	H
5	I	I
Completion Time	16	16

Figure 9. Critical path representation (CP1 and CP2)

It shows that the total duration of the project is diminished with 9 weeks, being in this case of 16 weeks. The critical path's activities are the same, being also presented in the table above. The project cost become 483 thousands $, by 188 thousands $ higher that the case of normal duration.

2.3. Sensitivity Analysis

This type of analysis allows us to apply some restrictions referring to the project budget or duration and to determine cost repartition in the direction that this one will be as low as possible.

For our project, the total duration is desired to be 15 weeks. In case that the project is finalized earlier, the bonus offered is an amount of 20 thousands $ / week, and for delays, the forfeit is 5 thousands $ / week. These elements will be specified in the corresponding window for *Solve and Analyze -> Perform Crashing Analysis* option. The obtained after wood results are presented in figure 10.

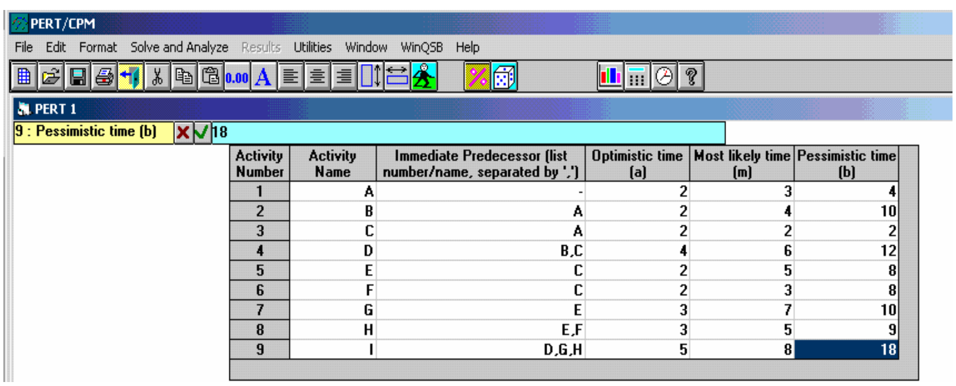
It is obvious that the project can not be finished earlier than 16 weeks, with the total cost of 423 thousands$, with 123 thousands$ over the normal cost for project development.

07-10-2008 16:54:20	Activity Name	Critical Path	Normal Time	Crash Time	Suggested Time	Additional Cost	Normal Cost	Suggested Cost
1	A	Yes	3	1	1	$20	$10	$30
2	B	Yes	4	3	4	0	$40	$40
3	C	Yes	2	2	2	0	$20	$20
4	D	Yes	6	4	6	0	$30	$30
5	E	Yes	5	4	4	$13	$25	$38
6	F	no	3	2	3	0	$15	$15
7	G	Yes	7	4	4	$36	$45	$81
8	H	Yes	5	4	4	$6	$30	$36
9	I	Yes	8	5	5	$48	$80	$128
	Late	Penalty:						$5
	Overall	Project:			16	$123	$295	$423

Figure 10. Results for finalizing the project in 15 weeks

3. PERT Method.

We start from the same project, with 9 activities, marked A – I and with the same precedence. The optimistic durations, the most probable and the pessimistic ones are reproduced in the figure below:



Activity Number	Activity Name	Immediate Predecessor (list number/name, separated by ',')	Optimistic time (a)	Most likely time (m)	Pessimistic time (b)
1	A	-	2	3	4
2	B	A	2	4	10
3	C	A	2	2	2
4	D	B,C	4	6	12
5	E	C	2	5	8
6	F	C	2	3	8
7	G	E	3	7	10
8	H	E,F	3	5	9
9	I	D,G,H	5	8	18

Figure 11. Problem data for PERT method

Figure 12 shows that the finalizing duration of the project is 26 weeks and the activities A, C, E, G and I are critical.

We apply a restriction to the project duration (figure 13).

From figure 13 emerge that the probability of finalizing the project in 20 weeks is 1.25%, and if we force the duration to 23 weeks, the probability is 13.12%. To finalize the project in 26 weeks is stipulated a percentage of 50%.

07-11-2008 02:22:51	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	Yes	3	0	3	0	3	0	3-Time estimate	0,3333
2	B	no	4,6667	3	7,6667	5,5	10,1667	2,5	3-Time estimate	1,3333
3	C	Yes	2	3	5	3	5	0	3-Time estimate	0
4	D	no	6,6667	7,6667	14,3333	10,1667	16,8333	2,5	3-Time estimate	1,3333
5	E	Yes	5	5	10	5	10	0	3-Time estimate	1
6	F	no	3,6667	5	8,6667	7,8333	11,5	2,8333	3-Time estimate	1
7	G	Yes	6,8333	10	16,8333	10	16,8333	0	3-Time estimate	1,1667
8	H	no	5,3333	10	15,3333	11,5	16,8333	1,5	3-Time estimate	1
9	I	Yes	9,1667	16,8333	26	16,8333	26	0	3-Time estimate	2,1667
	Project	Completion	Time	=	26	weeks				
	Number of	Critical	Path(s)	=	1					

Figure 12. Results on matrix form

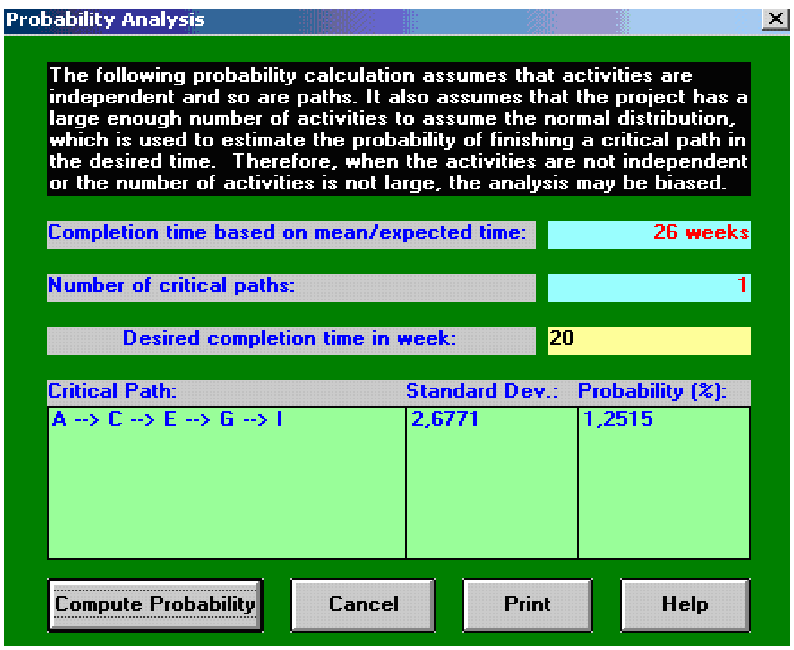


Figure 13. *Probability Analysis* window

After simulation of 1000 hours, we obtain that the project duration is 26.27 weeks (figure 14).

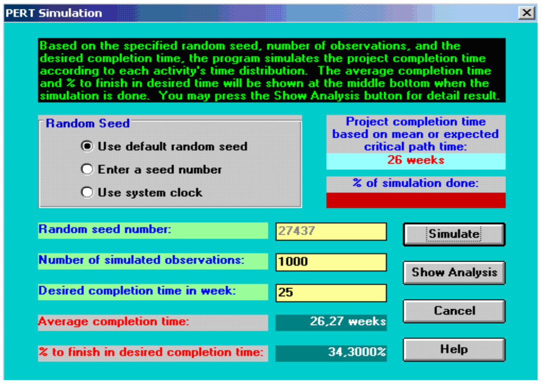


Figure 14.

4. Conclusions

The CPM method provides, as showed, helpful information for the management process, but doesn't face fact of the possible variations of the execution times of the activities.

The PERT method tries to correct this fact. In order to accomplish this, the method allows calculating the average duration for finishing a project, identifying the critical activities along with previsions estimation of the planned terms.

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