PERT & CPM Approach to CE-Optimal Plans

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Abstract. Construction activity of huge/big office buildings, is an indicator of a state's economic progress not only because the activity prominently contributes to capital formation but also to National reconstruction. The last mentioned aspect is particularly true of countries like Eritrea (N. E. Africa) that were ruined by different colonizers. Thus a critical appraisal into the time frame and hence economic aspects of construction activities upto completion, occupies a pre-eminent place in OR research and practice. The object of this paper is to focus on the high use of deploying the PERT & CPM method/analysis to appraise the two huge construction activities undertaken by M/s Keangnam (Korean) Enterprises, Limited and M/s Raza Enterprises, at Asmara, (Eritrea). Asmara is the capital city of the state of Eritrea. Eritrea is situated in the North-Eastern part of Africa and is pride-fully called as the Horn of Africa because of : Military, Trade, Geographical and other international-strategic reasons.

1. Introduction and Motivation

Eritreans are in the period of reconstruction of their state which was ruined by different colonizers. Constructing buildings and palaces largely resolves the current problem of housing. So the basic aim of this paper is to focus the applicational use of the "PERT" (Program Evaluation & Review Technique) and "CPM" (Critical Path Method) techniques which are crucial for an analysis of the sequence of the project activities from their start to completion. Another objective of this paper is to sideline the general thumb-rules of planning and co-ordinating practised by most managers and possibly replace these with the use of the networks of CPM & PERT techniques especially in the context of large-scale construction-project activities.

Specifically, we concentrated on the large-scale construction activities of :

(i) Keangnam (Korean) Enterprises Limited (KEL) and

(ii) Raza Enterprises (RE) in Asmara.

2. Methods and Materials

The method deployed in this paper, as indicated, is the PERT & CPM. The justification for the use of PERT & CPM consists in the fact that these are the *Two Formal Planning Methods* by which varied activities of a project can be co-ordinated on a time-oriented basis. Thus the application of PERT and CPM analysis leads to effective, optimal, economic and efficient management of the overall project management. We name such management as : Cost-effective-optimal planning" (CEOP). The aim of the present work is to identify and suggest CEOP's to the two Enterprises :

(i) KEL and (ii) RE.

We can now list the purpose and consequent advantages emerging by deployment of CEOP's in the following.

1. Scientific estimates of optimal time for completion of the construction projects of KEL (Housing Bank offices located the Sembel Residential complex, Asmara) and RE (large scale constructions at Asmera)

2. Planning the sequence of activities after identifying the potential bottlenecks and such activities which are not potentially critical to the project completion on time

3. Avoidance of unnecessary costs and economising by cutting the possible losses arising out of following other non- optimal schedules (paths)

4. Identify the *Critical Path* and such most significant and economically feasible activities that may crucially participate in the timely completion of the project

5. To suggest useful controls that lead to optimal savings in time and construction costs.

3. Data Analysis, Conclusions, Results and Recommendations

3.1 Keagnam Enterprises Ltd. : Data and Analysis
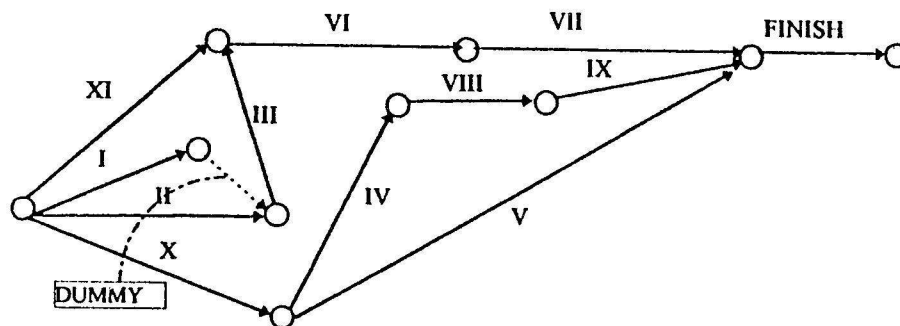
Data Analysis : Figure 1 : Network Diagram Extracted From the Table (# 1)

Table 1. Construction Activities of Sembel Housing Bank Office

Item #	Activity Description	Immediate predecessors	Expected Time (Tc)	Project Requirement
I	Foundation & Structure work (A)	None	6 months	20 %
II	Foundation & Structure work (B)	None	8 "	25 %
III	Bricks Work	I & II	7 "	2 %
IV	Concrete fair facing work	X	3 "	1.5 %
V	Water Proofing work	X	9 "	1.5 %
VI	Plastering Door work	VI	5 "	3 %
VII	Framing Door work	XI, III	10 "	20 %
VIII	Ceramic Tile Work	IV	3 "	2 %
IX	Ceiling work	XI	8 "	1 %
X	Mechanical Work	None	5 "	14 %
XI	Electrical Work	None	12 "	10 %

Nakfa 5,970,000 (100%)

[Note : 01 Nakfa (Nf) = 5.4 INR and USD = 7.4 Nf]

Table 2. Early Start (ES), Late Start (LS) & Slack (LS-ES)

| Item #	Activity Description	Early Start(ES)	Late Start(LS)	Slack (LS-ES)
I	Foundation & Structure work (A)	0	2	2
II	Foundation & Structure work (B)	0	0	0
III	Brick work	8	8	0
IV	Concrete Fair Facing work	5	16	11
V	Water Proofing work	5	21	16
VI	Plastering Door work	15	15	0
VII	Framing Door work	25	25	0
VIII	Ceramic Tile work	15	19	4
IX	Ceiling work	18	22	4
X	Mechanical work	0	11	11
XI	Electrical work	0	3	3
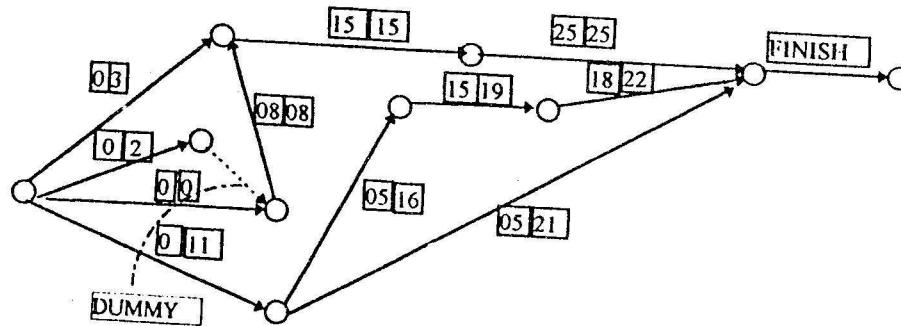
Figure 2 : Net-Work Diagram Used to Compute ES & LS of The Activities Using by the Forward Path & Backward Path-Method.

3.2   Conclusion and Recommendations

The above analysis leads to the "Critical Path", the path from I to II to III to VI to VII constituting the activities : Foundation & structural work (A)-Bricks work-Plastering door work-Framing door work, for the project of constructing the building. Furthermore, the KEL management teams estimated of the total time for completion of the overall project as 40 months is not vindicated by the analysis which places the estimate for completion as 30 months.

Thus, the management is well advised to follow the critical path indicated though our results in this study, that is the early start of activity VII (25 months) plus the projected time for completion of activity VII (5 months).

Further the following recommendations follow from our analysis to the project management of Sembel Housing Bank Construction :

1. The management may keep a keen control of the activities which are included in the critical path. These are Foundation & structural work (A)-Brick work-Plastering door work-Framing door work. From table 2 the above critical activities have a slack time of zero. This implies that a slight delay on any one of these activities will lead to an overall delay for the project completion.

2. The management is advised to follow and direct the operations as per the time schedule extracted from the network diagram for completion of the project in time.

3. The management may initiate further study (in depth and detail) about the economic feasibility of the activity for further savings in time which was possibly reduce even months duration for project completion.

3.3 Raza Enterprises

The Data Analysis

Table 3. Activities of Raza Enterprises

	Activities of Raza Enterprises	Immediate predecessors	Expected Time (t_c) (in Weeks)
(A)	Basement level	None	8
(B)	Excavation for foundation	A	1
(C)	Cast for footing & column	B	3
(D)	Basement slab & hard core	C	1
(E)	Brick wall of basement	C	3
(F)	Plastering to the brick wall of basement	E	4
(G)	Ground floor columns, concrete works	D	2
(H)	First floor slab	F & G	2
(I)	Brick wall of first floor	F & G	3
(J)	Plastering to the brick wall ground	I	4
(K)	First floor column & form work	H	2
(L)	Plastering to the brick wall first floor	J & K	4
(M)	Second floor slab	L	2
(N)	Second floor column & form work	L	2
(O)	Brick wall of second floor	N	3
(P)	Roof slab	M	2
(Q)	Plastering to the second floor	O & P	3
(R)	Installing Electricity	Q	4
(S)	Plumbing & Sanitary	Q	4
(T)	Fixing doors & Windows	R	3
(U)	Pour Tiles (floor)	S	5
(V)	Painting	T & U	8

Source : Official Records of Raza Enterprises

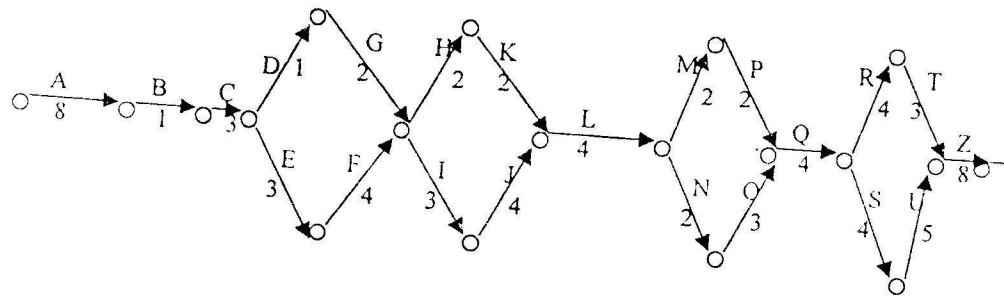N.Venugopal, M.V.Durga Prasad, T.V.R.Mohan & M.M.Bai

Figure 3. The Network (Precedence) Diagram of Raza Enterprises

Critical Path : The longest path in terms of time, equating the expected project duration for completion, given by Figure-3 turns out to be the longest path through the following activities

A - B - C - E - F - I - J - L - N - O - Q - S - U - Z = 56 Weeks

Thus, the project is expected to complete within 56 weeks from the start.

Table 4. ES, LS and SLACK

Activity	Time (t_c) (in weeks)	Early		Late		Slack (LS-ES or LF-EF
		ES	EF	LS	LF	
A	8	0	8	0	8	0
B	1	8	9	8	9	0
C	3	9	12	9	12	0
D	1	12	13	16	17	4
E	3	12	15	12	15	0
F	4	15	19	15	19	0
G	2	13	15	17	19	4
H	2	19	21	22	24	3
I	3	19	22	19	22	0
J	4	22	26	22	26	0
K	2	21	23	24	26	3
L	4	26	30	26	30	0
M	2	30	32	31	33	1

Activity	Time (Tc) (in weeks)	Early		Late		Slack (LS-ES or LF-EF
		ES	EF	LS	LF	
N	2	30	32	30	32	0
O	3	32	35	32	35	0
P	2	32	34	33	35	1
Q	4	35	39	35	39	0
R	4	39	43	41	45	2
S	4	39	43	39	43	0
T	3	43	46	45	48	2
U	5	43	48	43	48	0
Z	8	48	56	48	56	0

Zero slack time represents activities on the critical path.

ES - Early start, LS - Late start, EF - Early finish, LS - Late finish

3.4. Conclusion and Recommendation

On the basis of the above investigation and analysis, the following conclusion and recommendations emerge :

1. The Raza Enterprises indicated that their scheduled plan of work may be completed within 18 months (that is 78 weeks). However, as per the above analysis employing CPM, only 56 weeks time is sufficient for successful completion of their project.

2. Thus it is recommended that management of Raza enterprises may profitably implement the sequence of activities as suggested by the network.

3. Finally Raza Enterprises may take a critical notice of the activities (corresponding to zero slack time) such as A, B, C, D, E, F and so on that determine the critical path.

The above two case studies reveal the indispensable need to subject large-scale construction projects to PERT & CPM analysis before finalising their work-schedules.

References

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