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APPLICATION OF PROJECT MANAGEMENT TECHNIQUES IN A CONSTRUCTION FIRM

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ABSTRACT

An important aspect of life cycle management in construction project development is project planning and control. There are five elements in project planning techniques: project planning, monitoring, reporting, collection of statistics and re-planning. The study presents the techniques and strategy for planning and controlling project activities, development of the network diagram and determination of critical path using the critical path method. The probability of meeting up the stipulated time was 65 percent along the critical path and the sub-critical paths while the minimum project duration was 98 weeks.

Keywords: *Life Cycle Management, Project Planning, Project Monitoring, Critical Path Method, Project Duration*.

INTRODUCTION

Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. This is achievable by planning, organizing, controlling and supervising of project (Dinsmore, 2005; Cordell, 1986). Over the years, in this nation there have being projects left half-hazard, abandoned, dejected and rejected due to poor management practices. Project management has been practiced since early civilization. Until 1900 civil engineering projects were generally managed by creative architects and engineers themselves. It was in the 1950s that organizations started to systematically apply project management tools and techniques to complex engineering projects (Young, 2002; Elmaghraby, 1977). It become recognized as a distinct discipline arising from the management discipline with management model, prior to the 1950s, project were managed on ad-hoc basis using mostly Gantt charts and informal techniques and tools. Two mathematical project-scheduling models were developed, the "critical path" (CPM) and Programme Evaluation and Review Techniques (PERT) were developed for projects evaluation (Martin, 2002). Network models most readily apply to physical decision problem such as the transportation of materials, the flow of fluids materials through interconnecting pipes to different reservoirs, and construction of large project works (Dennis, 2007)

The deleterious effects of delay in construction projects in Nigeria can not be over emphasized. It is therefore imperative that various studies on project management techniques be routinely carried out, in order to provide mathematical information that would assist in decision making. This study entailed the application of programme evaluation review techniques in the analysis of construction project by probabilistic procedures. It provides rules that are necessary in constructing a project, which enabled project managers to evaluate their project work with the network analysis.

Project Management Techniques

This research study is meant to ascertain the relevance of project management techniques on successful project completion on due time without delay by industries. Project management techniques employ the use of PERT (Project Evaluation and Review Technique) and CPM (Critical Path Method) tools. They can be summarized as explained in following steps:

i. Determine or estimate precedence relationships and duration times for each activity required to complete the project.

ii. Construct a network model from the relationships and duration times. Arrows are used to represent activities and nodes used to represent the starting and ending point of an activity. Two different activities are not allowed to have the same starting and ending nodes, so occasionally dummy activities are required in construction of the network.

iii. For each activity i, calculate the earliest possible start time (ES) and earliest completion time (EC), by making a "forward pass" through the network. The earliest starting time of all activities which have no predecessors are set to zero. The earliest completion time of each activity is equal to the earliest completion time plus the activity duration time(T). The earliest start time for activities with predecessors is equal to the maximum of the earliest completion times of all immediate predecessors to the activity. The completion time for the project is equal to the maximum of the latest completion time of all activities.

iv. The latest start time (LS) and latest completion time (LC) of all activities are calculated in a "backward pass" through the network. The latest completion time of activities with no successors are set equal to the completion time of the project. The latest start time of an activity is calculated by subtracting its activity time from its latest completion time. The latest completion time for an activity is equal to the minimum of the latest start time of all activities which succeed it.

v. Calculate the slack (S) for each activity by subtracting the earliest start time (ES) from the latest start time (LS). The slack for each activity represents the amount of time an activity may be delayed from its earliest start time without delaying the project.

vi. Identify the critical path, which is made up of activities for which the slack is equal to zero.

vii. Determine the mean time using equation one.

$$t = \frac{(a+b+4m)}{6} \qquad (5)$$

Where
a = Pessimistic time.
b = Optimistic time
m = Most likely.

viii. Compute the standard deviation using equation two.

$$\delta = \left(\frac{b-a}{6} \right) \qquad (6)$$

Where
a = Pessimistic time.
b = Optimistic time.

ix.Estimate the probability of completing the project within the scheduled date using equation three.

$$Z = {X-\mu}/{\delta} \qquad (7)$$

Where
X = Scheduled date for the completion of project.
μ = Completion time along path(s).
The manpower with the durations and level are finally scheduled for better performance and results.

Data Collection

The information for this analysis is obtained from FECEC global hunted construction company situated in Delta state, Nigeria. It comprised the job description, actual time durations, duration limits, immediate predecessor of the activities and the estimated cost of labour, which is depicted in table 1.

Table 1: Results from Analysis

Activity	Job Description	Actual Duration	Duration Limits (weeks	Immediate Predecessor	Estimated Cost of
A	Surveying	5	4 – 12	…….	100,000
B	Site clearing	7	5 – 9	A	150,000
C	Removal of stumps	8	4 – 12	A	50,000
D	General excavation	5	3 – 10	B	78,000
E	Grading of Area	10	6 – 20	B	100,000
F	Excavation of trenches	6	2 – 14	C	80,000
G	Work Placement and Concrete Reinforcement	12	8 – 16	D	500,000
H	Molding of block and interlocks	20	14 – 32	E,F	100,000
I	Installation of sewers line	10	7 – 16	C	180,000
J	Pouring of concrete	7	4 – 16	G	300,000
K	Laying of blocks	10	5 – 20	H,I	1,800,000
L	Erection of slabs	10	5 – 20	I	150,000
M	Electrification works	8	2 – 12	J	400,000
N	Plastering and flooring	15	7 – 28	K	600,000
O	Roofing and fixing of frames	10	6 – 20	L	450,000
P	Painting and placing of interlocks	12	6 – 15	M,N,O	480,000

Data Analysis Techniques

Immediate predecessor of each activities is constructed in accordance to activities precedence for the construction of network diagram, due to uncertainties in construction projects, assuming all activities durations are independent random variables the mean and variance of the critical path is calculated (David, 2006; Diekmann 1983). The mean and variance of the duration of activities are depicted on Table 2. Assuming that the activity duration follow a probabilistic beta distribution under a restrictive condition. The probability density function of beta distribution for a random variable x is given by (Dickmann 1983).

$$f(x) = k(x-a)^{\alpha}(b-x)^{\beta}$$

$$a \le x \le b \ \ and \ \ \alpha, \beta > 1$$

Where k is a constant expressed in term of α and β.

The mean, $\mu = \dfrac{a + (\alpha+\beta)m + b}{\alpha+\beta+2}$

$$\mu_{ij} = \frac{1}{6}(a_{ij} + 4m_{ij} + b_{ij})$$

The variance $(\sigma_{ij}^2) = \dfrac{1}{36}(b_{ij} - a_{ij})^2$

When α and β are beta distribution parameters.

The probability of normal distribution

$$P_r(P_D) = P_r(Z \le P_D - \mu_D)$$

In the analysis, the three random variables a, m, and b are assumed as beta distribution parameters and beta distribution is often used to characterize activity durations since it has an absolute minimum and absolute maximum of possible durations. The beta parameters are not directly used to construct a network – diagram rather they are converted to normal distribution parameters with mean value (μ) and variance (σ^2). The mean values are used to construct the network diagram and then numbering events algorithm is applied to determine the minimum project duration as presented in Figure 1.

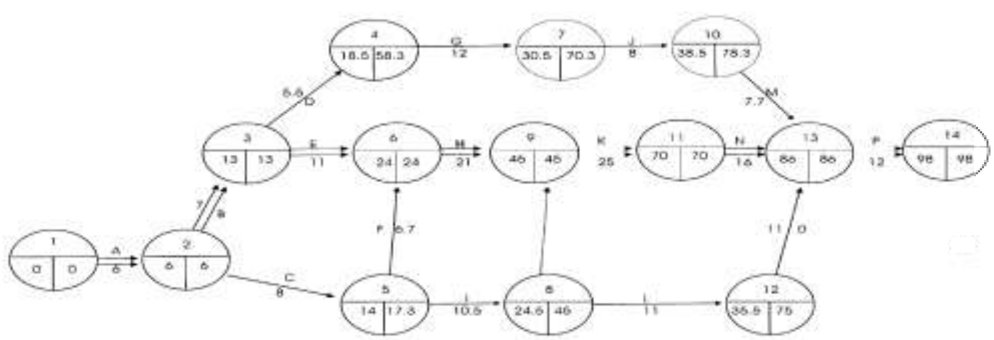

Figure 4.2: A Seventeen - Activity Project Network

Table 2: The Duration of Activities

Activities	Events		Mean Durations	EST	EFT	LST	LFT	IF	FF
	I	II							
A	1	2	6	0	6	0	6	0	0
B	2	3	7	6	13	6	13	0	0
C	2	5	8	6	14	9.3	17.3	3.3	0
D	3	4	5.5	13	18.5	53	58.5	40	0
E	3	6	11	13	24	13	24	0	0
F	5	6	6.7	14	24	17.3	24	0	0
G	4	7	12	18.5	30.5	58.3	70.3	39.8	0
H	6	9	21	24	45	24	45	0	0
I	5	8	10.5	14	24.5	39.5	45	20.5	0
I^1	8	9	0	24.50	45	45	45	0	0
J	7	10	8	30.50	38.5	70.3	78.3	41.8	0
K	9	11	25	45	70	45	70	0	0
L	8	12	11	24.5	35.5	84	75	39.5	0
M	10	13	7.7	38.50	86	78.3	86	0	0
N	11	13	16	70	86	70	86	0	0
O	12	13	11	35.5	86	75	86	0	0
P	13	14	12	86	98	86	98	0	0

Table 3: Result of Critical Paths Analysis

Critical Paths	Probability (%)
1	74.2
2	100
3	100
4	88.3
5	100

This is clearly explained as presented in Figure 2 with probability of 74 to 100 percent which is quite good for the firm.

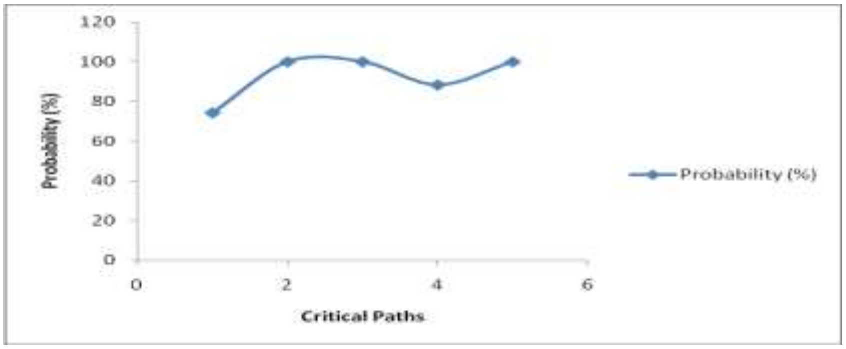

Fig. 2: Probability of Job Completion on Time.

DISCUSSION

The values of earliest start, latest start and activities determined from heuristic algorithms in table 2, shows that the critical activities are along the path, A, B, E, H, K, N, and P, the value of earliest and latest starts durations are equal, this show that decreasing the durations the project will be ahead of estimated time and an increase in the durations due to constraints the project will exceed the stipulated deadline. From the probabilistic estimation the probability of meeting the project deadline when all the paths are assumed critical was 65percent showing the feasibility of the network-diagram, the critical activities in the computations are assumed to be independent. Hence the sum of the duration is approximately normal by the central theorem. (Kerzner, 1984), in the analysis the paths in the network are considered independent and as such the critical path may not necessarily be the one having the lowest probability of completion by the scheduled dates. And the minimum time duration to complete the entire project was 98 weeks by heuristic algorithm.

CONCLUSION

Project planning and control is simply concerned with the use of network diagram to present activities in order of priority. It enables the project manager to be able to coordinate, plan and schedule control activities. Here in a project plan network the interest problem of interest is to determine the length of time required to complete the project and the set of critical activities that control the project completion time. Other areas of interest where the application of network optimization modeling can prove useful include transportation, shortest path, maximum flow of lids e.t.c., these arrears have been included and according described to give better insight to modeling applicability in the previous chapter. Therefore for successful management of a project, the project manager must need to plan, co-ordinate and control. He should continually be making adjustments by starting activities before activities completes. He may also needs to sub-contract activities, re-negotiate deliverables while always keeping senior management informed.

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