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Analysis and Improvement by the Application of Network Analysis (Pert/Cpm)

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----------Abstract----------
Purpose: *The aim of this paper is showing the PERT/CPM methodology. In this paper it was introduced the way of implementing the PERT/CPM in the project base company.*
Design/ methodology/approach: *In the frames of own research it has been analyzed and implemented the PERT/CPM in the live project.*
Findings: *On the basis of the own research it can be stated, that implementing the PERT/CPM techniques bring the great changes in the company, for example: process improvement by time & cost reduction, increasing of effectiveness and efficiency in the processes, proceedings according to decisions, better control, utilization of resources.* ***Research limitations/implications:*** *The CPM/PERT techniques permit to analyze the processes and control the activities in the project. The CPM/PERT is the methodology of creation and maintaining well organized, well controlled, and high effective project work.*
Practical implications: *Own research clearly showed, that very essential thing is to divide activities and define the best way or path to perform these activities.* ***Originality/value:*** *PERT/CPM improves project management and provides better control over activities and project time.*

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I. Introduction

Project: A project is a temporary Endeavour involving a connected sequence of activities and a range of resources, which is designed to achieve a specific and unique outcome and which operates within time, cost and quality constraints and which is often used to introduce change. Examples

–constructing houses, factories, shopping malls, athletic stadiums or arenas

–developing military weapons systems, aircrafts, new ships

–launching satellite systems

–constructing oil pipelines

–developing and implementing new computer systems

–introducing new products into market

Project management: The application of a collection of tools and techniques to direct the use of diverse resources towards the accomplishment of a unique, complex, one time task within time, cost and quality constraints.

Work breakdown structure:

- A method of breaking down a project into individual elements (components, subcomponents, activities and tasks) in a hierarchical structure which can be scheduled and cost
- It defines tasks that can be completed independently of other tasks, facilitating resource allocation, assignment of responsibilities and measurement and control of the project
- It is foundation of project planning
- It is developed before identification of dependencies and estimation of activity durations
- It can be used to identity the tasks in the CPM and PERT.

Project Planning:

Resource Availability and/or Limits

- Due date, late penalties, early completion incentives
- Budget

Activity Information

•Identify all required activities

•Estimate the resources required (time) to complete each activity

•Immediate predecessor(s) to each activity needed to create interrelationships

Project Scheduling and Control Techniques:

Gantt chart

Critical Path Method (CPM)

Program Evaluation and Review Technique (PERT)

History of CPM/PERT:

Critical Path Method (CPM)

- E I Du Pont de Nemours & Co. (1957) for construction of new chemical plant and maintenance shut-down
- Deterministic task times
- Activity-on-node network construction
- Repetitive nature of jobs

Project Evaluation and Review Technique (PERT)

- U S Navy (1958) for the POLARIS missile program
- Multiple task time estimates (probabilistic nature)
- Activity-on-arrow network construction
- Non-repetitive jobs (R & D work)

Project Network:

- Network analysis is the general name given to certain specific techniques which can be used for the planning, management and control of projects.
- Use of nodes and arrows

Arrows → An arrow leads from tail to head directionally

– Indicate ACTIVITY, a time consuming effort that is required to perform a part of the work.

Nodes ● A node is represented by a circle

-Indicate EVENT, a point in time where one or more activities start and/or finish.

- Activity

– A task or a certain amount of work required in the project

– Requires time to complete

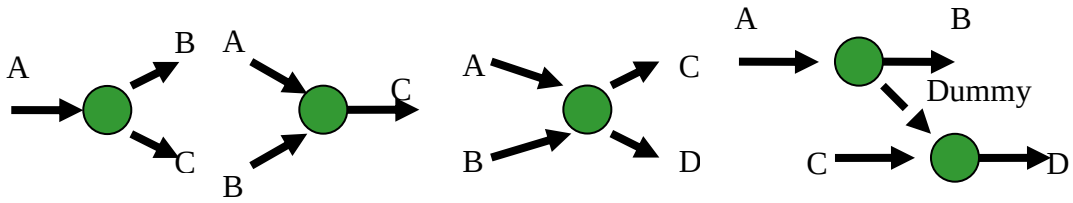
– Represented by an arrow

- Dummy Activity

– Indicates only precedence relationships

– Does not require any time of effort

Situations in network diagram:



A must finish Before either B or C can start

both A and B must finish before C can start

both A and B must finish before C and D start

A must finish before B can start and A and C must finish before D

Questions to prepare activity network:

The key question is: How long will it take to complete this project?

1. Is this a Start Activity?
2. Is this a Finish Activity?
3. What Activity Precedes this?
4. What Activity Follows this?
5. What Activity is Concurrent with this?

CPM calculation:

- Path-A connected sequence of activities leading from the starting event to the ending event
- Critical Path-The longest path (time); determines the project duration
- Critical Activities-All of the activities that make up the critical path

Forward Pass

- Earliest Start Time (ES)
  – earliest time an activity can start
  – ES = maximum EF of immediate predecessors
- Earliest finish time (EF)
  – earliest time an activity can finish
  – earliest start time plus activity time

EF= ES + *t*

Backward Pass

- Latest Start Time (LS)

Latest time an activity can start without delaying critical path time

LS= LF - *t*

- Latest finish time (LF)

Latest time an activity can be completed without delaying critical path time

LS = minimum LS of immediate predecessors

CPM analysis:

- Draw the CPM network
- Analyze the paths through the network
- Determine the float for each activity
  – Compute the activity's float
  Float = LS - ES = LF - EF
  – Float is the maximum amount of time that this activity can be delay in its completion before it becomes a critical activity, i.e., delays completion of the project
- Find the critical path is that the sequence of activities and events where there is no "slack" i.e... Zero slack
  – Longest path through a network
- Find the project duration is minimum project completion time

PERT:

- PERT is based on the assumption that an activity's duration follows a probability distribution instead of being a single value
- Three time estimates are required to compute the parameters of an activity's duration distribution:
  – pessimistic time (tp) - the time the activity would take if things did not go well
  – most likely time (tm) - the consensus best estimate of the activity's duration
  – optimistic time (to) - the time the activity would take if things did go well

Mean (expected time): $te = \frac{tp + 4\,tm + to}{6}$

PERT analysis:

- Draw the network.
- Analyze the paths through the network and find the critical path.
- The length of the critical path is the mean of the project duration probability distribution which is assumed to be normal
- The standard deviation of the project duration probability distribution is computed by adding the variances of the critical activities (all of the activities that make up the critical path) and taking the square root of that sum

Probability computations can now be made using the normal distribution table. **Probability computation:**
Determine probability that project is completed within specified time

$$Z = \frac{x - \mu}{\sigma}$$

Where μ = tp = project mean time
σ = project standard mean time
x = (proposed) specified time

Cost consideration in project:

- Project managers may have the option or requirement to crash the project, or accelerate the completion of the project.
- This is accomplished by reducing the length of the critical path(s).
- The length of the critical path is reduced by reducing the duration of the activities on the critical path.
- If each activity requires the expenditure of an amount of money to reduce its duration by one unit of time, then the project manager selects the least cost critical activity, reduces it by one time unit, and traces that change through the remainder of the network.

- As a result of a reduction in an activity's time, a new critical path may be created.
- When there is more than one critical path, each of the critical paths must be reduced.
- If the length of the project needs to be reduced further, the process is repeated.

II. Own Research:

Own research has been carried out in the field of planning management and control of projects. The project was external electrification work of scheme no. 34, neemuch (m.p.). the assigning body was Nagar Palika, Neemuch (m.p.). and it was executed by Bansal Projects Co. The network analysis (CPM/PERT) was Implemented and has given answers of following:

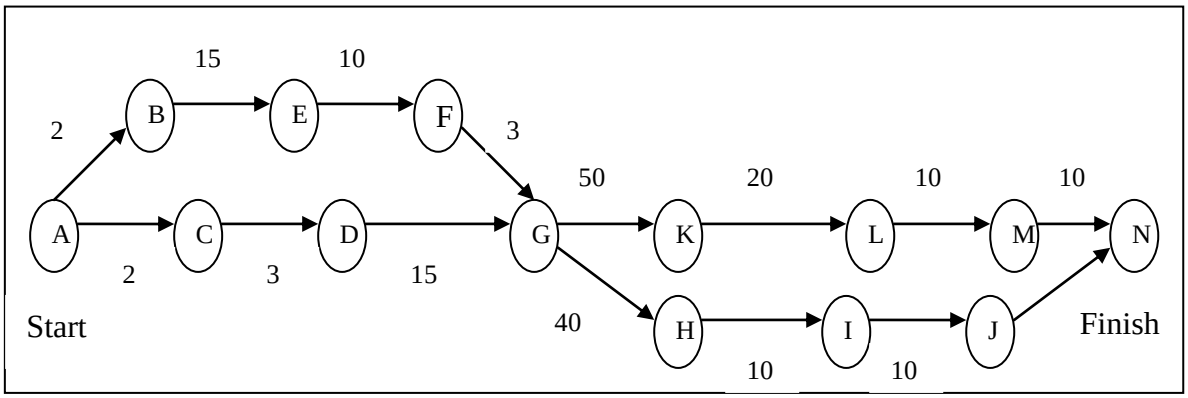
- Which are the critical activities or tasks in the project which could delay the entire project if they were not completed on time?
- Is the project on schedule, behind schedule or ahead of schedule?
- If the project has to be finished earlier than planned, what is the best way to do this at the least cost?

Work Breakdown Structure (W.B.S.) of external electrification work

A	Survey
B	Placing order for material
C	Construction of office at store site
D	To make holes in for poles
E	Receiving materials & paint on them
F	Material transportation to site
G	Erection of poles on the other hand P.C.C./C.M.T. of base & backfilling with bolder.
H	Making arrangement and fabrication of clamps & arms.
I	To tighten the material on poles (e.g. top clamps, V cross arm, D cross arm, stay, stud, insulator etc.)
J	Cable & conductor work on 11 KV. & L.T. line fixing of D.O. set AB switches
K	Installation of transformers (100 KVA & 200 KVA)
L	Wiring and distribution box, switches on transformers.
M	Energy meter installation
N	Testing

Illustration of network analysis of work

Activity	Predecessor (i)	Successor (j)	Activity duration (teij)
A	---	B,C	2
B	A	E	15
C	A	D	3
E	B	F	10
F	E	G	3
G	D,F	K,H	50
H	G	I	10
I	H	J	10
J	I	N	10
K	G	L	20
L	K	M	10
M	L	N	10



Activities A-B, B-E, E-F, G-K, K-L, L-M, M-N are the critical activities & the path A-B-E-F-G-K-L-M-N is the critical path.

Activity	Activity duration te	Earliest start time Es (i)	Earliest completion time Ec (ij)	Latest start time Ls (ij)	Latest completion time Lc(j)	Float
A-B	2	0	2	0	2	0
A-C	2	0	2	10	12	8
B-E	15	2	17	2	17	0
C-D	3	2	5	12	15	10
E-F	10	17	27	17	27	0
D-G	15	5	20	35	50	30
F-G	3	27	30	47	50	20
G-H	40	30	70	50	90	20
H-I	10	70	80	90	100	20
I-J	10	80	90	100	110	20
G-K	50	30	80	30	80	0
K-L	20	80	100	80	100	0
J-M	10	90	100	100	110	10
L-M	10	100	110	100	110	0
M-N	10	110	120	110	120	0
J-N	10	90	100	110	120	20

The path A-B- E-F-G-K-L-M-N is the critical path. In the execution of the project, it is critical path needs optimum care. Any delay in any activity on this path will upset the whole project and will delay is completion. That is why the name critical path is assigned to this path.

III. Conclusions

Benefits of CPM/PERT

- Useful at many stages of project management
- Mathematically simple
- Give critical path and slack time
- Provide project documentation
- Useful in monitoring costs

CPM/PERT can answer the following important questions:

- How long will the entire project take to be completed? What are the risks involved?
- Which are the critical activities or tasks in the project which could delay the entire project if they were not completed on time?
- Is the project on schedule, behind schedule or ahead of schedule?
- If the project has to be finished earlier than planned, what is the best way to do this at the least cost?

Limitations to CPM/PERT

- Clearly defined, independent and stable activities
- Specified precedence relationships

- Over emphasis on critical paths
- Deterministic CPM model
- Activity time estimates are subjective and depend on judgment
- PERT assumes a beta distribution for these time estimates, but the actual distribution may be different
- PERT consistently underestimates the expected project completion time due to alternate paths becoming critical

References

[1]. Project management with cpm and pert by Joseph J. Moder, Cecil R. Philips
[2]. An introduction to PERT/CPM Bruce N. Baker, Rene L. Eris3 Project Management by Edward Wilson Davis
[3]. Network-Based management Russell D. Archibald
[4]. Project Planning and Control with PERT & CPM By Dr. B.C. Punmia & K.K. Khandelwal.
[5]. Project Management Institute (2003). A Guide To The Project Management Body Of Knowledge (3rd ed. ed.). Project Management Institute. ISBN 1-930699-45-X.
[6]. Klastorin, Ted (2003). Project Management: Tools and Trade-offs (3rd ed. ed.). Wiley. ISBN 978-0-471-41384-4.
[7]. Kerzner, Harold (2003). Project Management: A Systems Approach to Planning, Scheduling, and Controlling (8th Ed. ed.). Wiley. ISBN 0-471-22577-0.
[8]. Milosevic, Dragan Z. (2003). Project Management ToolBox: Tools and Techniques for the Practicing Project Manager. Wiley. ISBN 978-0-471-20822-8.
[9]. Malcolm, D. G., J. H. Roseboom, C. E. Clark, W. Fazar Application of a Technique for Research and Development Program Evaluation OPERATIONS RESEARCH Vol. 7, No. 5,