Chapter 6 Scheduling (GIDO, Successful Project Management and others)

Estimate the duration for each activity
Establish the estimated start time and required completion time for the overall project
Calculate the earliest times at which each activity can start and finish, based on the project's estimated start time
Calculate the latest times by which each activity must start and finish in order to complete the project by its required completion time
Determine the amount of positive or negative slack
Identify the critical (longest) path of activities

Bar Chart Format

- A Gantt chart is a bar chart tool for planning and scheduling.
- Activities are listed on the left-hand side, and a time scale is shown along the bottom or the top.
- The estimated duration for each activity is indicated by a bar spanning the period during which the activity is expected to be accomplished.
- A column indicating who is responsible for each task can be added to the chart.
- Figure 5.12 depicts a bar chart for the consumer market study project.
- Project management software can automatically generate a time-scaled bar chart from the schedule table that is based on the network diagram.
- A traditional bar chart does not graphically display the dependent relationships of activities. Be sure to create the network diagram and connect the bars in the Gantt chart with arrows to show relationships.

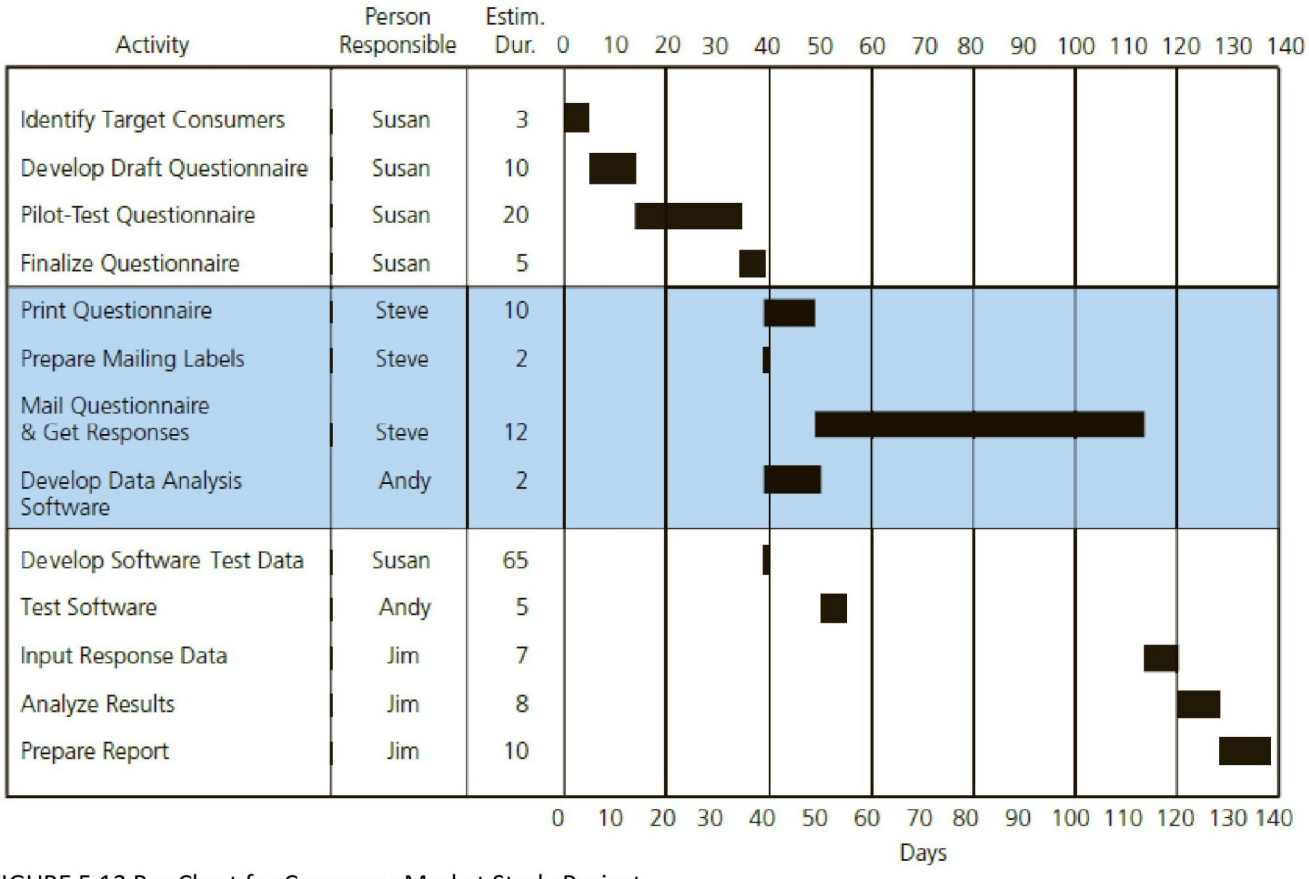


FIGURE 5.12 Bar Chart for Consumer Market Study Project

PERT and CPM

- **Network techniques**
- **Developed in 1950's**
  - **CPM by DuPont for chemical plants**
  - **PERT by U.S. Navy for Polaris missile**
- **Consider precedence relationships and interdependencies**
- **Each uses a different estimate of activity times**

Questions Which May Be Addressed by PERT & CPM

- Is the project on schedule, ahead of schedule, or behind schedule?
- Is the project over or under cost budget?
- Are there enough resources available to finish the project on time?
- If the project must be finished in less than the scheduled amount of time, what is the way to accomplish this at least cost?

The Six Steps Common to PERT & CPM

- Define the project and all of its significant activities or tasks
- Develop relationships among the activities. (Decide which activities must precede and which must follow others.)
- Draw the network connecting all of the activities
- Assign time and cost estimates to each activity
- Compute the longest time path through the network. This is called the critical path
- Use the network to help plan, schedule, monitor, and control the project

Advantages of PERT/CPM

- Networks generated provide valuable project documentation and graphically point out who is responsible for various project activities
- Applicable to a wide variety of projects and industries
- Useful in monitoring not only schedules, but costs as well

Limitations of PERT/CPM

- Assumes clearly defined, independent, & stable activities
- Specified precedence relationships
- Activity times (PERT) follow beta distribution
- Subjective time estimates
- Over-emphasis on critical path

Activity Duration Estimates

The first step in scheduling is to estimate how long each activity will take.
The *duration estimate* is the total elapsed time for the work to be done PLUS any associated waiting time.
The person responsible for performing the activity should help make the duration estimate.

Project Start and Finish Times

It is necessary to select an *estimated start time* and a *required completion time* for the overall project.

Schedule Calculations

A project schedule includes:

the earliest times (or dates) at which each activity can start and finish, based on the project's estimated start time (or date)
the latest times (or dates) by which each activity must start and finish in order to complete the project by its required completion time (or date)

Earliest Start and Finish Times

Earliest start time (ES) is the earliest time at which a particular activity can begin.
Earliest finish time (EF) is the earliest time by which a particular activity can be completed.

EF = ES + Duration Estimate

Earliest Start and Finish Times Rule #1

The earliest start time for an activity must be the same as or later than the latest of all the earliest finish times of all the activities leading directly into that particular activity.

Latest Start and Finish Times

Latest finish time (LF) is the latest time an activity must be finished in order for the entire project to be completed by its completion time.
Latest start time (LS) is the latest time an activity must be started in order for the entire project to be completed by its completion time.

LS = LF – Duration Estimate

Latest Start and Finish Times Rule #2

The latest finish time for a particular activity must be the same as or earlier than the earliest of all the latest start times of all the activities emerging directly from that particular activity.

Total Slack, Defined

Total slack (TS) or float is the difference between the calculated earliest finish time of the very last activity and the project's required completion time.

Total Slack = LF - EF or
Total Slack = LS - ES

If total slack is positive, it is the maximum time the activities on the path can be delayed.
If total slack is negative, it is the amount of time the activities on the path must be accelerated.

Toplam Bolluk (slack, float)

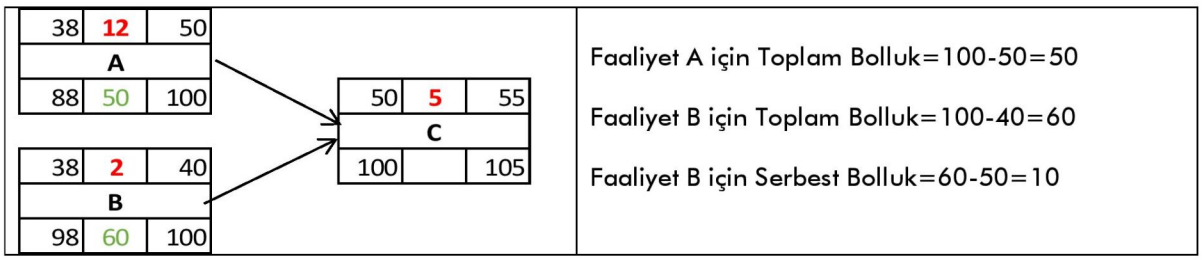
- Toplam Bolluk = LF - EF veya
- Toplam Bolluk = LS - ES
- Toplam gevşeklik(bolluk) pozitifse, bu süre, yoldaki etkinliklerin geciktirilebileceği maksimum süredir.
- Toplam gevşeklik(bolluk)negatifse, yoldaki faaliyetlerin hızlandırılması gereken süredir.

Serbet Bolluk(Free Slack)

Belirli bir faaliyetin süresinin, bir sonraki faaliyetin ES (en erken başlama) zamanını geciktirmeden uzatılabileceği süredir.

Hesaplanışı:

Belirli bir faaliyete bağlanan bütün öncül faaliyetlerdeki Toplam Bolluk sürelerinin en küçüğü bulunur.
O faaliyetin Toplam Bolluk süresinden diğer faaliyetlerdeki en küçük bolluk süresi çıkarılır.
Aynı faaliyete bağlanan faaliyetlerin toplam bolluk süreleri arasındaki nisbî (göreceli, relative) farkı verir.
Daima pozitif değerdedir.



Critical Path

- *Longest* path in network
- *Shortest* time project can be completed
- Any delay on critical path activities delays project
- Critical path activities have 0 slack

Kritik Yol

The critical path is the longest path in the network. Kritik yol ağdaki en uzun yoldur.
Critical paths have zero of total slack. Kritik yolların bolluğu sıfırdır.
Critical path is the shortest time project can be completed. Kritik yol projenin tamamlanabileceği en kısa zamandır.
Any delay on critical path activities delays project. Kritik yoldaki herhangi bir faaliyetteki gecikme projeyi de geciktirir.

Types of Critical Paths

Noncritical paths have positive values of total slack.
Critical paths have zero or negative values of total slack.
The *most critical path* is the longest critical path.

Free Slack

The amount of time an activity can be delayed without delaying the start of other activities.
It is the *relative difference* between the amounts of total slack for activities entering into the same activity.
It is always a positive value.

Scheduling for Information System Development

Some common problems that push IS projects past their required completion time:
Failure to identify all user requirements
Logical design flaws
Continuing growth of project scope
Underestimating learning curves for new software packages

Project Management Software

Allows one to perform scheduling functions.
Activity durations can be estimated in a variety of ways.
Project start and finish times can be entered in a variety of ways.
Can calculate dates, times, total and free slack.

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- **Expected project time (*T*)**
- **Sum of critical path activity times, *t***
- **Project variance (*V*)**
- **Sum of critical path activity variances, *v***
- These three times are combined into a single number, the expected activity completion time, given by

  Expected time=(a + 4m + b)/6
- **Essentially we can find answers to questions like:**
  - What is the probability that the project will take longer than...?
  - What is the probability that the project will be finished by...?

3 time estimates

- Optimistic times (*o*)
- Most-likely time (*m*)
- Pessimistic time (*p*)

Follow beta distribution

- Expected time: $t = (o + 4m + p)/6$
- Variance of times: $v = ((p - o)/6)^2$

FAALİYET	HEMEN BİR ÖNCEKİ FAALİYET	İYİMSER ZAMAN (o)	EN MUHTEMEL ZAMAN (m)	KÖTÜMSER ZAMAN (p)	FAALİYET	BEKLENEN ZAMAN (t)	Varyans (v)
A	-	4	5	6	**A**	**5**	$(P-O/6)^2 = .11$
B	-	6	8	10	**B**	**8**	.44
C	A	6	6	6	**C**	**6**	0
D	B	3	4	5	**D**	**4**	.11
E	B	2	3	4	**E**	**3**	.11
F	C,D	8	10	12	**F**	**10**	.44
G	E	6	7	8	**G**	**7**	.11
H	C,D	12	13	20	**H**	**14**	$(P-O/6)^2 = 1.78$
I	F,G	10	12	14	**I**	**12**	.44

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İhtimal (Olasılık) Temelleri

• Her faaliyet için üç zaman tahmini kullanan ağ planlaması, belirsizliğe izin verdiği için stokastik veya olasılıksal bir teknik olarak kabul edilebilir.
• Sadece bir kerelik tahmin kullanan herhangi bir teknik deterministik bir teknik olarak kabul edilir.
• Toplam olasılık dağılımı normal bir olasılık dağılımıdır.
• Bir faaliyetin beta olasılık dağılımına ilişkin varyans:

$$\text{Varyans} = \sigma^2 = (t_o - t_p/6)^2$$

• Standart sapma, bir dağılımın bir başka ölçüsüdür ve varyansın karekökünе eşittir.
• Kritik yol faaliyetlerinin toplam olasılık dağılımı normal bir dağılımdır.
• Ortalama, beklenen bireysel(tekil) faaliyet süresinin toplamına eşittir.
• Varyans bireysel(tekil) faaliyet varyanslarının toplamına eşittir.

İhtimal Hesaplanması

• Bir projeyi tamamlanma süresinden önce tamamlama olasılığı:

$Z = F(LF - EF, \sigma_t)$
LF = istenen tamamlanma süresi.
EF = en erken bitirme süresi.
σ_{cp}^2 = kritik yoldaki faaliyetlerin standart sapması.

• Z, normal olasılık eğrisinde EF ve LF arasındaki standart sapma sayısını ölçer.

$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}}$$

Probability Analysis

- D= desired completion date
- Te= expected completion date
- Sum of variance along the critical path (project standard deviation= √)

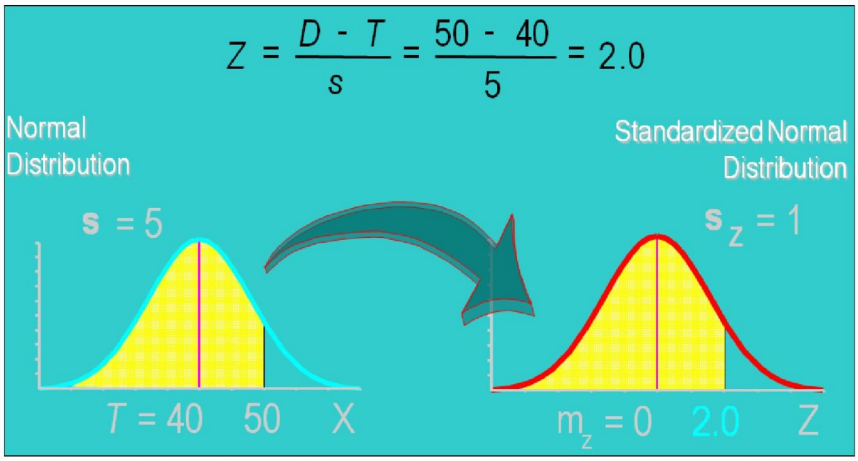
$$\sum \sigma^2 = 41$$

$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}}$$

PERT Probability Example

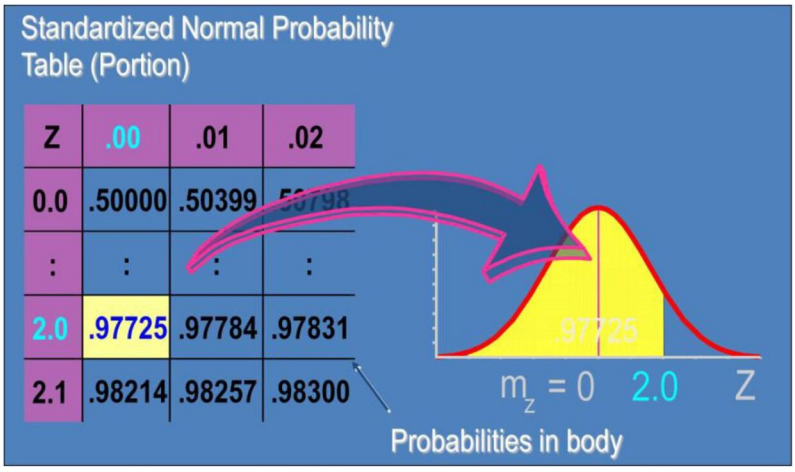
You're a project planner for General Dynamics. A submarine project has an expected completion time of 40 weeks, with a standard deviation of 5 weeks. What is the probability of finishing the submarine in 50 weeks or less?

Converting to Standardized Variable



Obtaining the Probability

Standardized Normal Probability Table (Portion)



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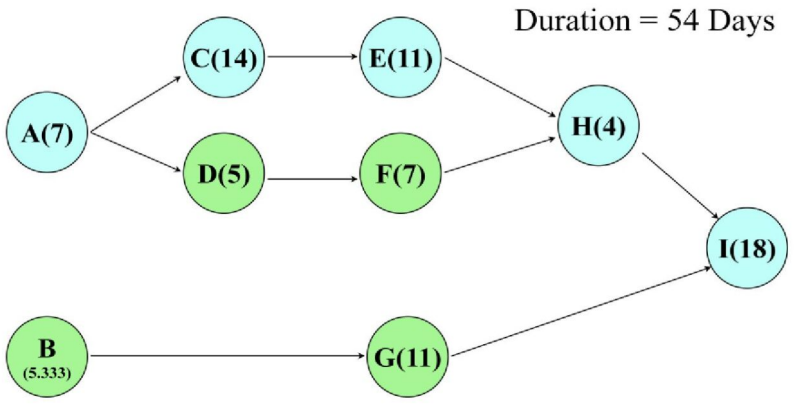


Task	Immediate Predecesors	Expected Time
A	None	7
B	None	5,333
C	A	14
D	A	5
E	C	11
F	D	7
G	B	11
H	E,F	4
I	G,H	18

A=7; C=14; E=11; H=4; I=18
7+14+11+4+18=54

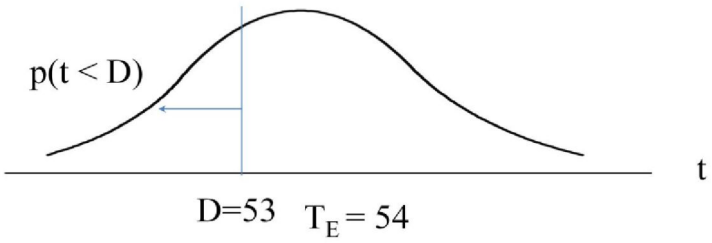
Task	Immediate Predecesors	Optimistic	Most Likely	Pessimistic	Variance
A	None	3	6	15	4
B	None	2	4	14	
C	A	6	12	30	16
D	A	2	5	8	
E	C	5	11	17	4
F	D	3	6	15	
G	B	3	9	27	
H	E,F	1	4	7	1
I	G,H	4	19	28	16

$$\sum \sigma^2 = 41$$

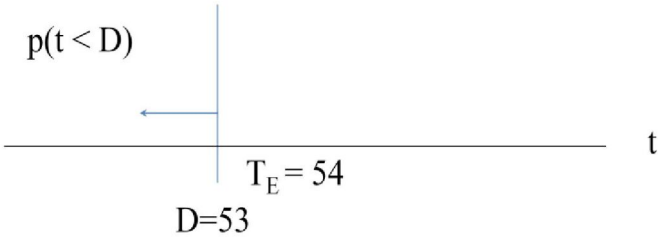
(Sum the variance *along the critical path.*)

Example Probability Exercise

What is the probability of finishing a project in less than 53 days if expected completion time is 54 weeks?



$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}}$$



$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}} = \frac{53-54}{\sqrt{41}} = -.156$$

p(Z < -0.156) =0.436, or 43.6 %

There is a 43.6% probability that this project will be completed in less than 53 weeks.

2.) Aşağıdaki tabloda bir projenin zamanları yer almaktadır. Tahmini süreler hesaplanmıştır.

Faaliyet	En iyimser	En muhtemel	En kötümser	Tahmini Süre	Bir ön faaliyet	ES	EF	LS	LF	Bolluk	variances (σ^2) $[(b-a)/6]^2$
A	1	4	7	4	-	0	4	0	4	0	$[(7-1=6)/6]^2 = 1$
B	2	2	2	2	-	0	2	7	9	7	$[(2-2=0)/6]^2 = 0$
C	2	5	8	5	A	4	9	4	9	0	$[(8-2=6)/6]^2 = 1$
D	3	4	5	4	A	4	8	11	15	7	$[(5-3=2)/6]^2 = 0,11$
E	4	6	8	6	C,B	9	15	9	15	0	$[(8-4=4)/6]^2 = 0,44$
F	0	0	6	1	C,B	9	10	20	21	11	$[(6-0=6)/6]^2 = 1$
G	3	6	9	6	D, E	15	21	15	21	0	$[(9-3=6)/6]^2 = 1$

2.1.) Bollukları hesaplayıp ilgili sütuna yazınız.

2.2.) Bir projenin süre bakımından tamamlanma ihtimalini hesaplamada kullanılan Z değerine esas olan varyansı (σ^2) bulunuz.

a,c,e,g

kritik yola ait) $\Sigma\sigma^2 = 1+1+0,11+0,44+1=$**3,44.**

$\sigma = \sqrt{3,44} = 1,855$

Z= (23-21) / 1,855 = 1,078; ihtimal: %85,9

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Task	Immediate Predecesors	Optimistic	Most Likely	Pessimistic	Task	Optimistic	Most Likely	Pessimistic	Variance
A	None	3	6	15	***A***	3	6	15	4
B	None	2	4	14	B	2	4	14	
C	A	6	12	30	***C***	6	12	30	16
D	A	2	5	8	D	2	5	8	
E	C	5	11	17	***E***	5	11	17	4
F	D	3	6	15	F	3	6	15	
G	B	3	9	27	G	3	9	27	
H	E,F	1	4	7	***H***	1	4	7	1
I	G,H	4	19	28	***I***	4	19	28	16

Not: Tahminî süreler şöyledir: {A=7; B=5; C=14; E=11; H=4; I=18}

$[(3-15)/6]^2 = 2^2 =$ **4**

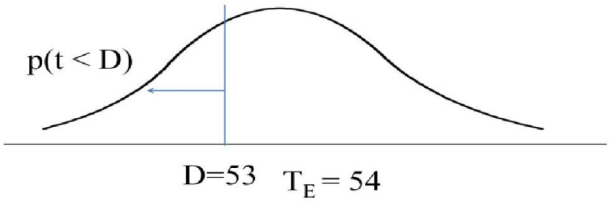
$[(6-30)/6]^2 = 4^2 =$ **16**

$[(5-17)/6]^2 = 2^2 = 4$
$[(1-7)/6]^2 = 1^2 = 1$
$[(4-28)/6]^2 = 4^2 = 16$
Toplam = 4+16+4+1+16=41.

(Sum the variance *along the critical path*.) $\sum \sigma^2 = 41$

İhtimal Sorusu Örneği:

Tahminî tamamlanma süresi 54 gün olan bir projenin 53 günde tamamlanma ihtimali kaçtır?



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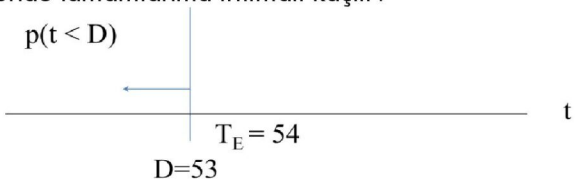

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There is a 43.6% probability that this project will be completed in less than 53 weeks.