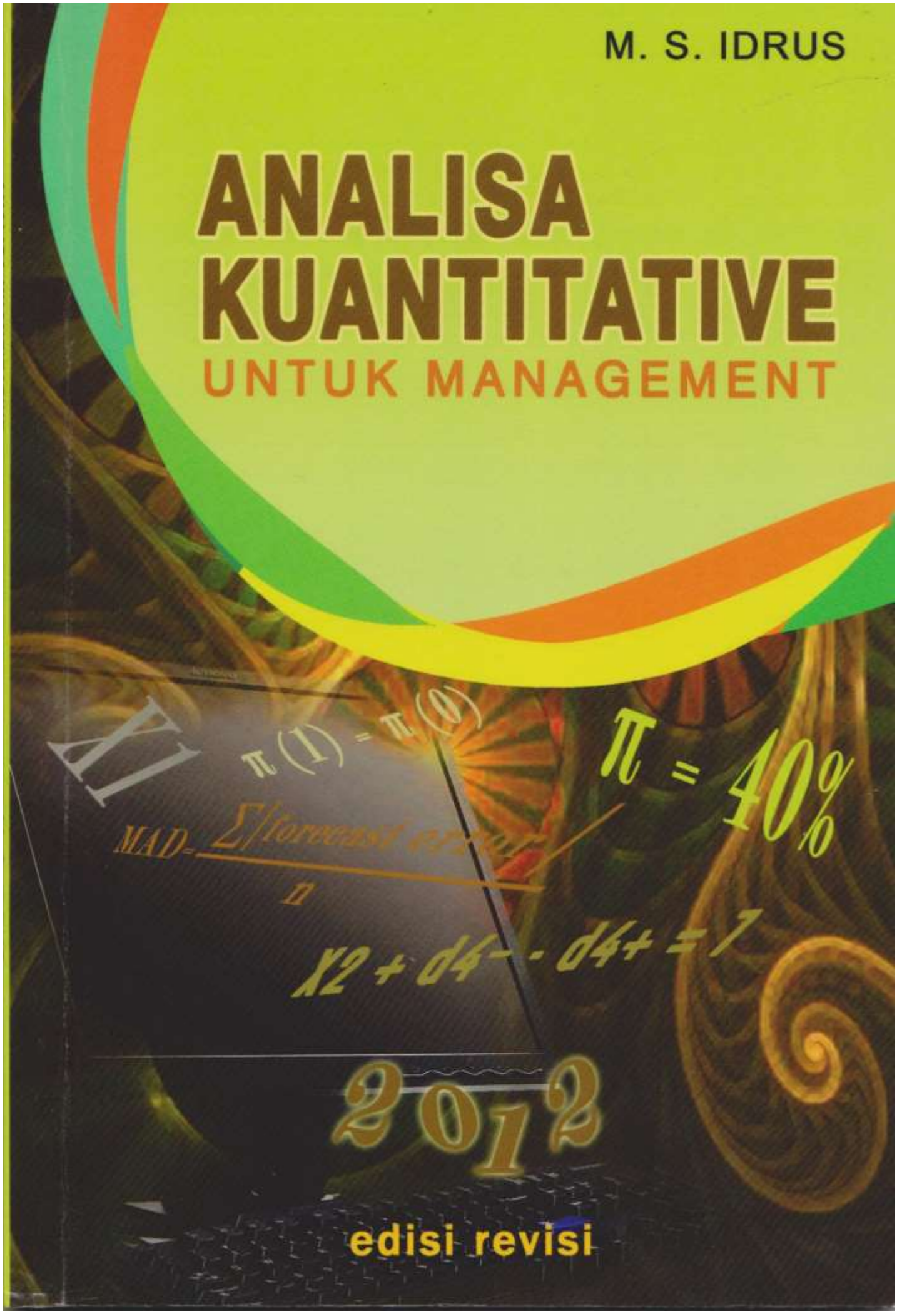
M. S. IDRUS

ANALISA KUANTITATIVE

UNTUK MANAGEMENT



edisi revisi

ANALISA KUANTITATIVE UNTUK MANAGEMENT

EDISI REVISI

M. S. IDRUS

2012

ANALISIA KUANTITATIVE UNTUK MANAJEMEN

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Kata Pengantar

Buku ini merupakan revisi edisi sebelumnya yang diterbitkan dengan ISBN 978-979-17971-9-1 pada tahun 2009. Edisi sebelumnya masih perlu disempurnakan lagi untuk memberikan materi yang sesuai dengan perubahan lingkungan dunia usaha.

Materi juga tetap dipersiapkan untuk membantu mahasiswa yang sedang menempuh mata kuliah 'quantitative analysis for management' atau disebut juga dengan 'operation research' dengan textbook standard dari Render B, Stair jr R M and Hanna M E yang diterbitkan pada tahun 2003 atau 2006, dan 2012) yang berjudul ***Quantitative Analysis for Management***, (8^{th} atau 9^{th} maupun 11^{th} edition) bersama dengan text tersebut dilampirkan software - ***QM for Windows versi 4*** (contoh text book dapat dilihat pada Bab 1 Pendahuluan).

Kami telah lama dipersiapkan dan telah dijadikan e-book pada Jurusan Manajemen Fakultas Ekonomi Universitas Brawijaya dan dapat dilihat pada **msidrus@fe.unibraw.ac.id**

Banyak permintaan agar materi tersebut dapat dipergunakan oleh kalangan yang lebih luas, maka dengan segala keterbatasan, bahan ini diterbitkan, dengan penjelasan yang tidak terlalu terinci (detail).

Terima kasih kami kepada penerbit dan saudara **Dr. Priyono MS**, dapat membantu mereview buku dan juga dalam penerbitan buku ini. Semoga para pembaca terutama para mahasiswa Management baik Program Sarjana maupun Program Pascasarjana memperoleh manfaat dari buku ini, Amin.

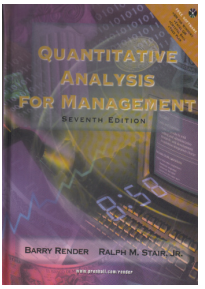
Januari 2012

M S Idrus

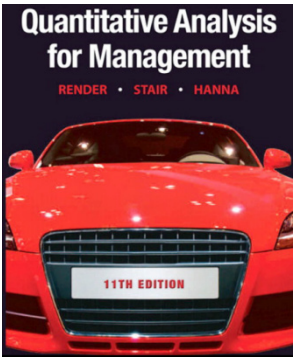
Daftar Isi

Bab 01 PENDAHULUAN

1.1. Textbook 7th ed (2000), dan 11th ed (2012)



2002



2012

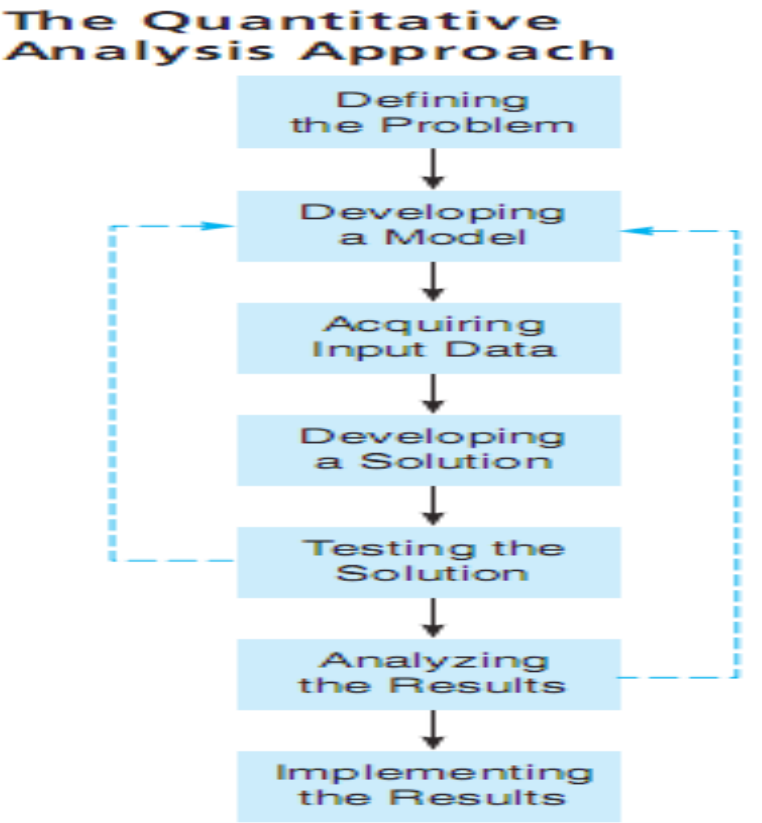
BRIEF CONTENTS

1.2. Apa Quantitative Analysis (QA) ?

QA adalah scientific approach to managerial decision making

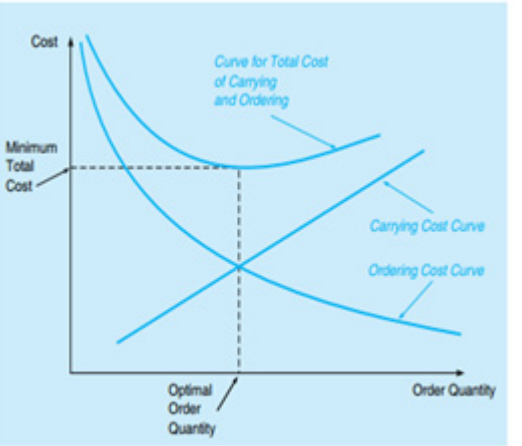
1.3. Bagaimana pendekatan yang digunakan oleh QA ? *– SEE P3 2012 edition*

Figure 1.1



Contoh model misalnya:

- **BEP model -→ π = TR – TC**
- **Model Inventory berikut ini,**



Economic Order Quantity (EOQ) Model

$$\text{Annual ordering cost} = \frac{D}{Q}C_o$$

$$\text{Annual holding cost} = \frac{Q}{2}C_h$$

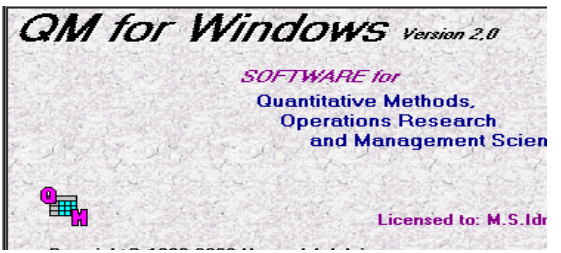
$$\text{EOQ} = Q^* = \sqrt{\frac{2DC_o}{C_h}}$$

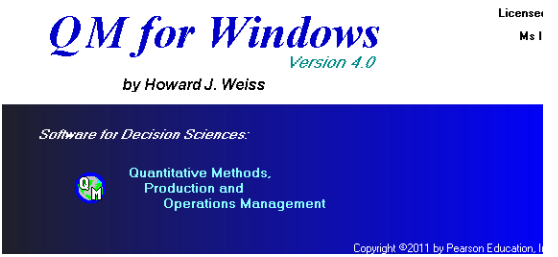
1.4. Situasi yang yang dihadapi oleh Management dan model kuantitative yang mungkin dipergunakan :

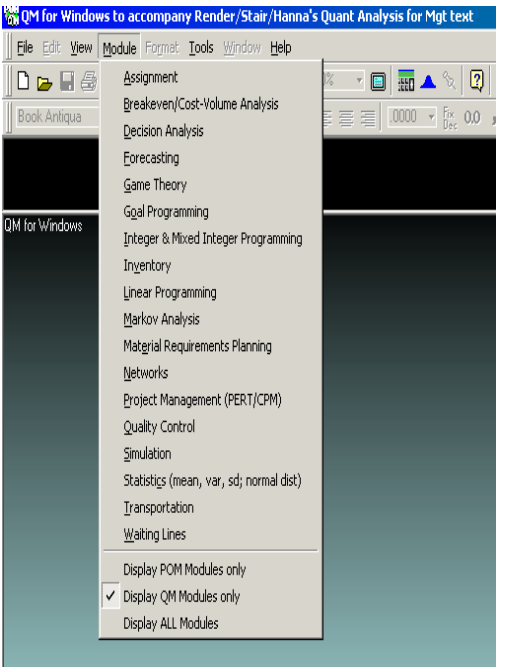
Situasi - Certainty	Risk	Uncertainty	Conflict
BEP with Calculus (M-6)	Probability (2)	Simulation (14)	Game Theory (M-4)
Model Kuantitative yang dapat dipergunakan a.l. : Liniear Programming (7 to 9)	Decision Analysis (3)	Inventory analysis with uncertain demand (6)	Markov Analysis (15)
Integer Programming (10)	Queuing analysis (13)		
Goal Programmming (10)	Dynamic Programming (M-2)		
Inventory analysis with certain Demand (6)	Forecasting (5)		
Network Flow model (11)			
CPM/PERT (12)			
Keterangan : Angka dalam kurung ( ) adalah bab dimana materi tersebut berada pada textbook utama 2012			

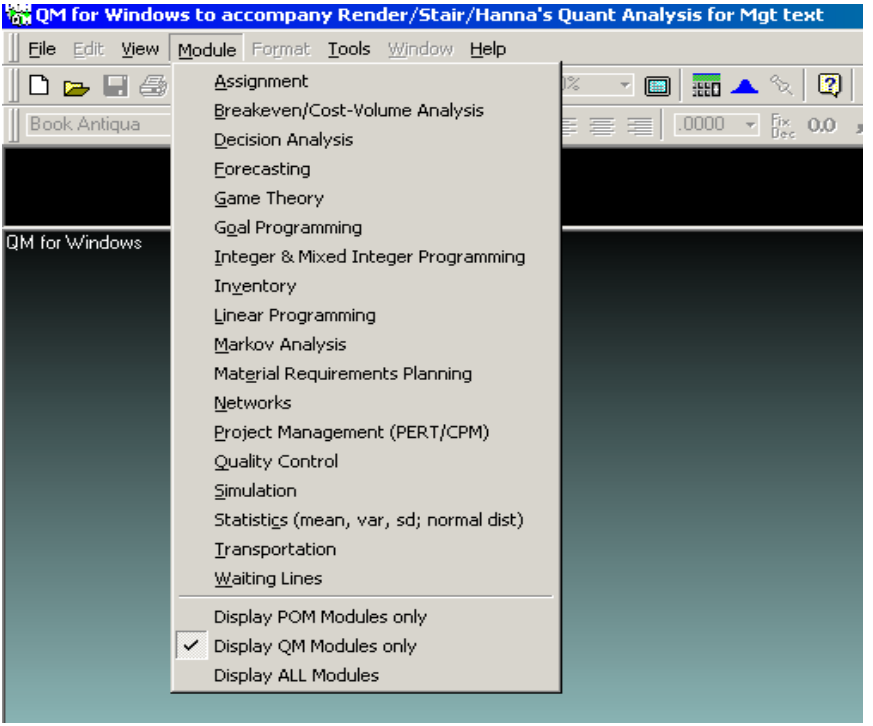
1.5. Paket yang dipergunakan

Paket yang dipergunakan adalah :

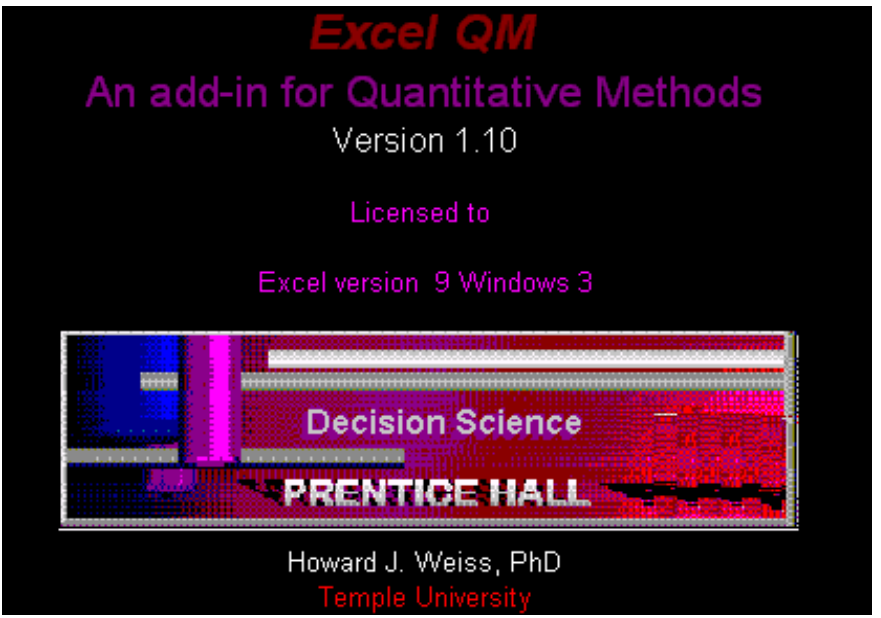


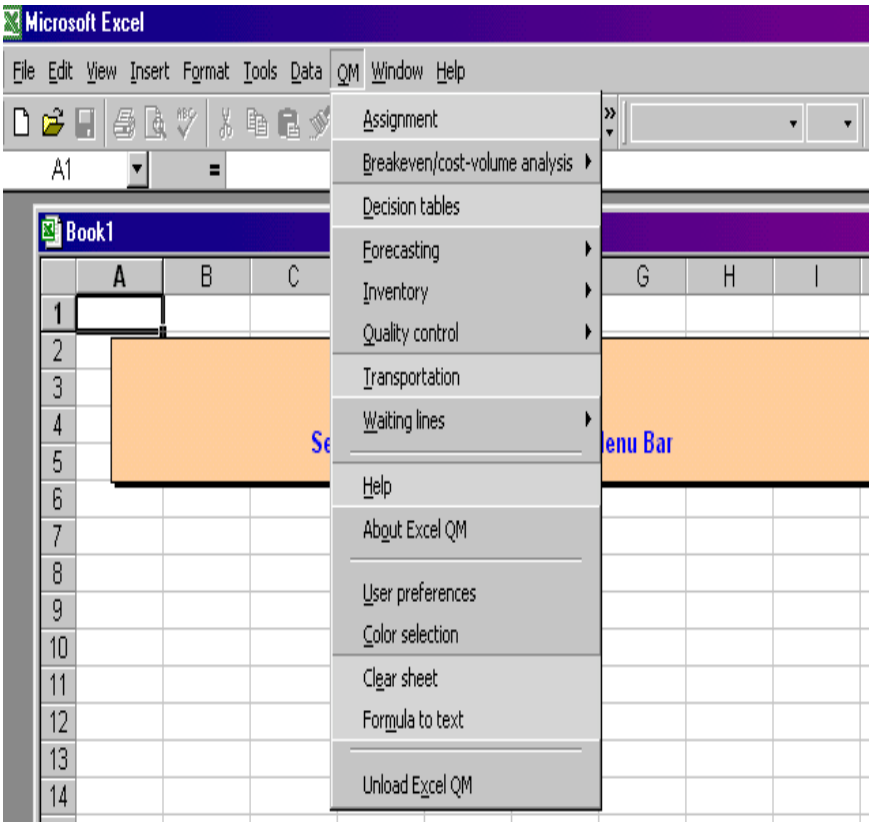






Atau modul Excel sbb :





Modul lainnya seperti :

- AB-POM
- AB-QM
- QS dan TORA
- LINDO
- QSB

Untuk keperluan kita saat ini cukup modul : QM for windows dan Qm-Excel diatas.

Bab 02 | MODEL DECISION THEORY

1.2. 6 (enam) langkah pada pengambilan Keputusan

No.	Langkah Langkah	Contoh
1	Mendifinisikan problema dengan jelas	Misalkan: apakah perusahaan melakukan expansi /tidak
2	Lakukan listing beberapa alternatives yang dapat dilakukan	Misalkan alternative tsb a.l. : • Expansi dengan mendirikan pabrik besar • Pabrik kecil • Atau tidak berbuat apa apa
3	Cari / identifikasi outcomes yang mungkin terjadi	Misalkan : • Pada situasi pasar yg favorable • Atau yang tidak favorable
4	Hitung payoff or profit untuk masing masing alternative pada outcome tertentu	Contoh terlihat pada tabel berikut, dan lihat pula halaman 83 pada textbook

5	Pilih salah satu dari model model decision theory	Misalkan : • Decision making under risk (expected monetary value; expected value of perfect information; opportunity loss; sensitivity analysis) • DM under uncertainty (maximax; maximin;equal likely (Laplace); creterion of realism (Hurwicz creterion); minimax)
6	Applikasikan model yang dipilih dan lakukan pengambilan keputusan	Lihat hasil komputer berikut ini.

Contoh sbb : LIHAT halaman (atau diberi kode P (page) seterusnya) 71- text tahun 2012 (atau disingkat p071-2012)

	State of Nature (scenarios)	
Alternatives (options)	**Favorable Market ($)**	**Unfavorable market ($)**
1. Mendirikan pabrik besar atau	**200,000**	**-180,000**
2. Pabrik kecil, atau	**100,000**	**-20,000**
3. Do nothing	**0**	**0**

Jika kondisi yang dihadapi management under risk (probabilitas dapat diperhitungkan sbb :

- Jika kemungkinan kondisi pasar baik (Probabilitas favorable market) = 0.5

- **EMV** (expectec monetary value) atau rata rata keuntungan yang diharapkan = (Payoff the 1st of state nature (perolehan pada kondisi pertama) dikalikan dengan (*) probabilitasnya) ditambah dengan (+) …dstnya…… (payoff the last * probalitasnya) → menghasilkan maximum EMV

- **EVPI** (atau expected value dari dari informasi yang tersedia/sempurna/perfect = (best outcomes 1st state of nature (perolehan terbaik pada kondisi pertama) dikalikan dengan (*) probilitasnya) + …dstnya….. (best outcome the last * probabilitasnya) dikurangi dengan ***maximum EMV***

- **Expected opportunity loss (EOL)** dihitung dengan mencari terlebih dahulu 'apa yang akan terjadi jika ***the best alternative pada setiap state of nature tidak dipilih*** (caranya pilih yang terbaik dahulu, kemudian susun payoff matixnya, dan carilah EOLnya (yaitu payoff * probabilitasnya) yaitu dengan mencari MINIMUM REGRET

- **Sensitivty analysis** dihitung dengan mencari range probabilitas favorable market dimana do nothing terbaik, atau probabilitas dimana small plant terbaik dilakukan atau large plant terbaik dilakukan. Misalkan probilitas favorable market = p, maka EMV small plant = EMV large plant pada saat 100000p-20000(1-p) sama dengan 200000p –180000(1-p) atau 120000p-20000 = 380000p – 180000 atau p = 160000/260000 = 0.62 dan EMV do nothing = EMV small pada p = 0.176

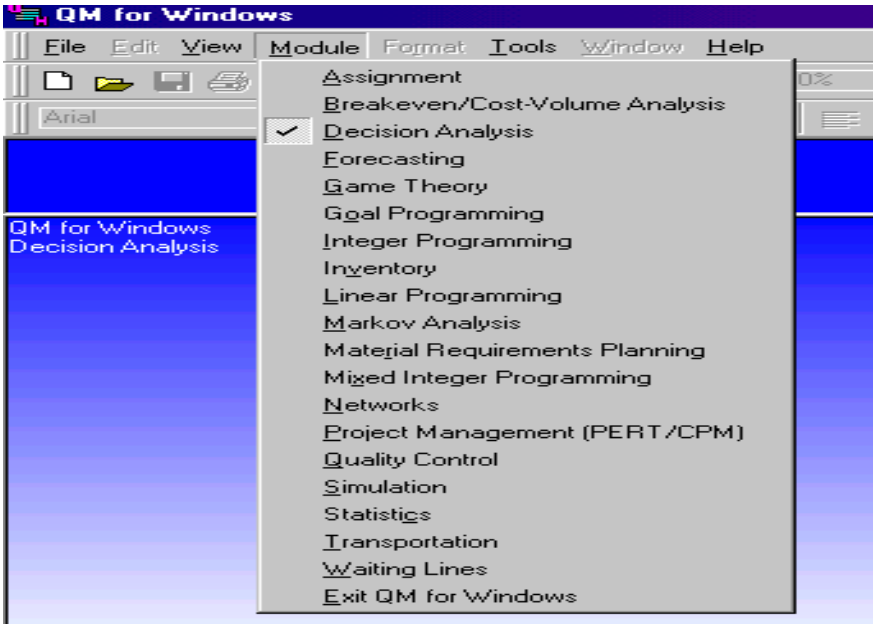
    - Keputusan yang dapat dilakukan jika p < 0.167 do nothing
    - Jika 0.167 <p< 0.62 small plant yang didirikan, dan
    - Jika > 0.62 didirikan pabrik besar

Jika Under uncertainty :

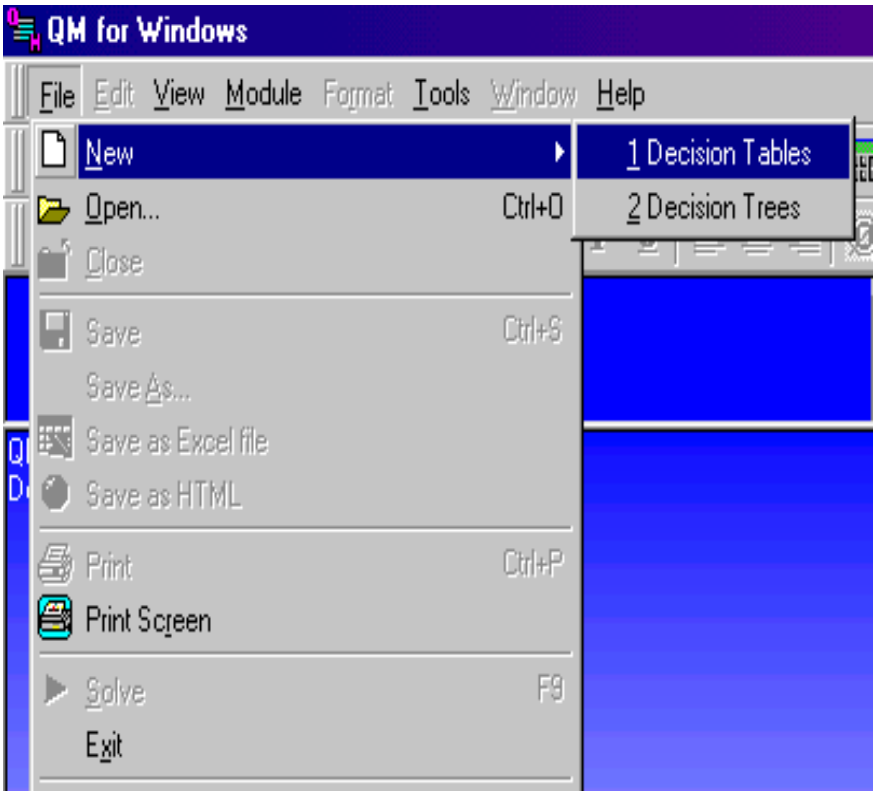
- Maximax dapat dilakukan → maximum gain dari maximum outcomes (optimistic)
- Maximin → maximum gain dari minimum outcomes(pessimistic)
- Equal likely (Laplace) → equal probability
- Minimax → Minimize dari Maximum opportunity Loss (misalkan disini tidak memilih outcome $200000, pada pabrik besar apa yang terjadi ?

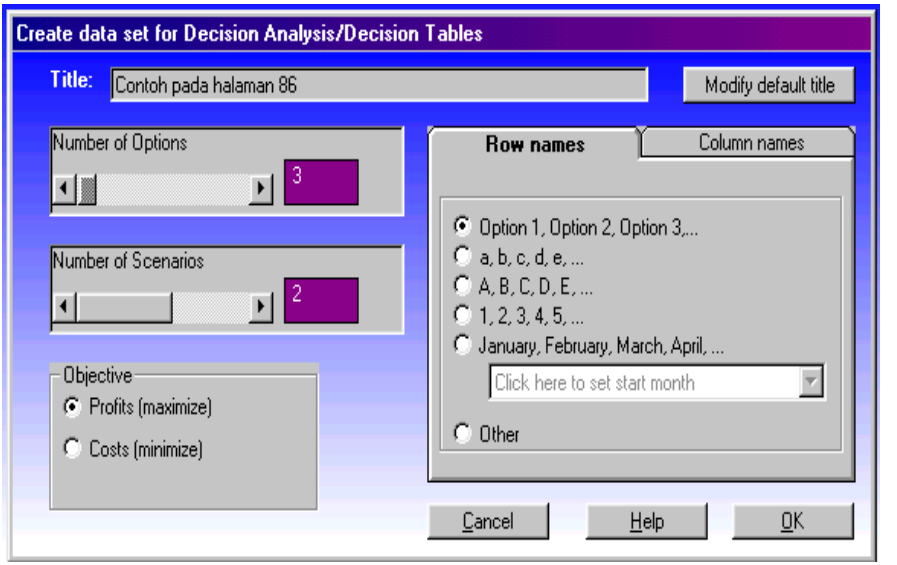
Cara mengerjakan dengan komputer sbb :

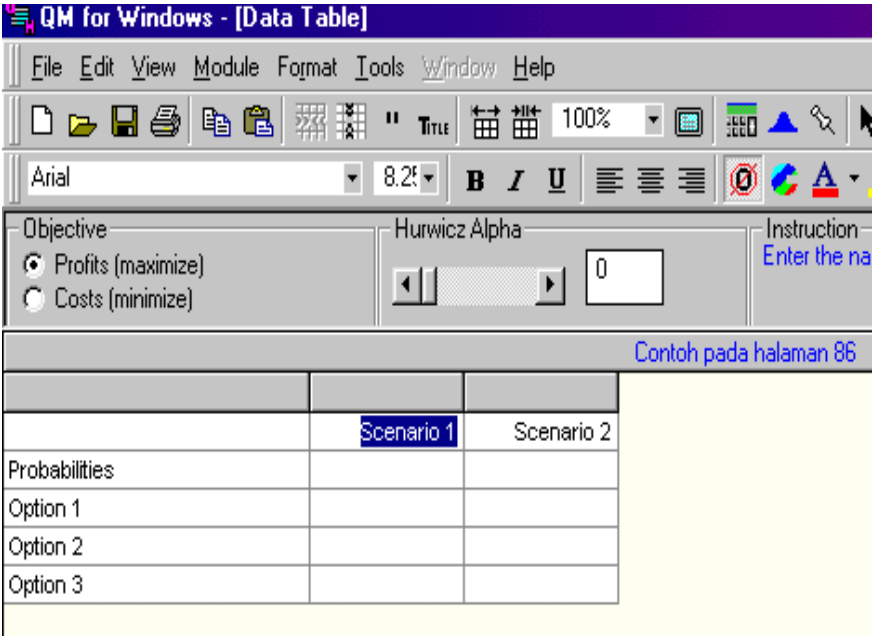
Step 1. Memanggil paket QM – **Decision Analysis** sbb :



Step 2. Masukkan datanya sbb :




Create data set for Decision Analysis/Decision Tables
Title:
Contoh pada halaman 86
Modify default title
Number of Options
3
Number of Scenarios
2
Objective
Profits (maximize)
Costs (minimize)
Row names
Column names
Option 1, Option 2, Option 3,...
a, b, c, d, e, ...
A, B, C, D, E, ...
1, 2, 3, 4, 5, ...
January, February, March, April, ...
Click here to set start month
Other
Cancel
Help
OK


QM for Windows - [Data Table]
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Profits (maximize)
Costs (minimize)
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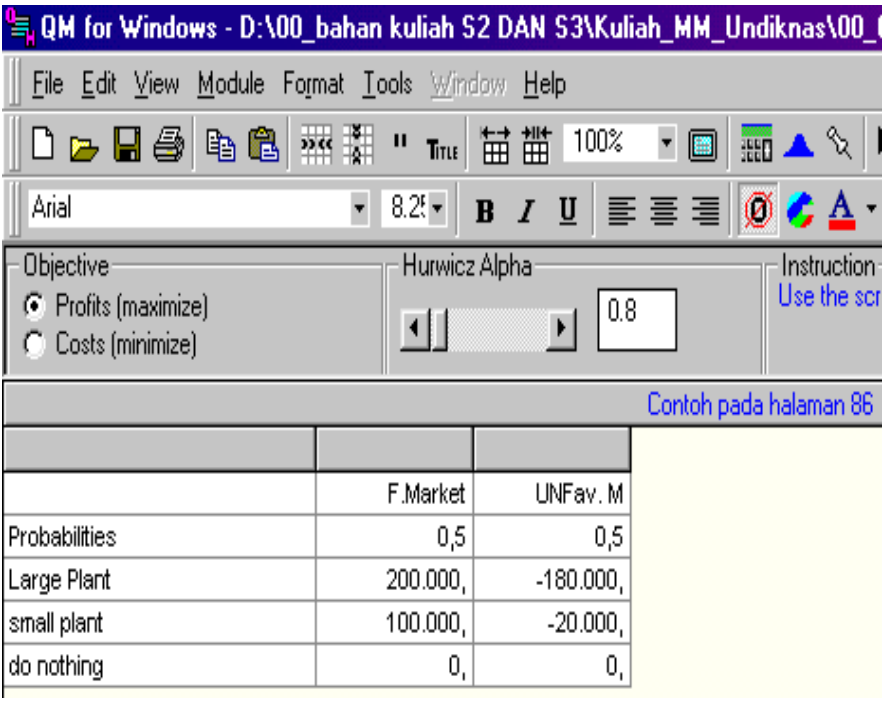
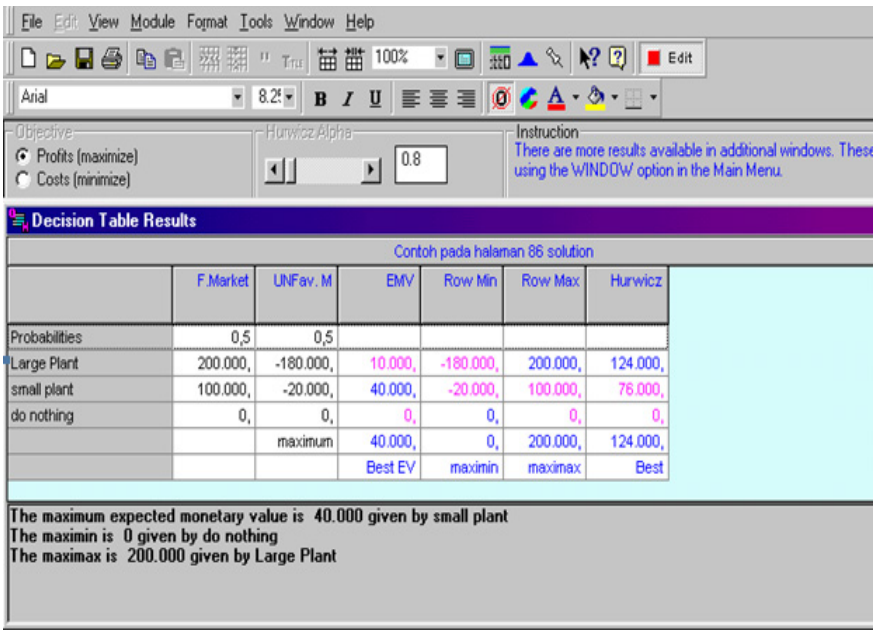
Contoh pada halaman 86
Scenario 1
Scenario 2
Probabilities
Option 1
Option 2
Option 3



	F.Market	UNFav. M
Probabilities	0,5	0,5
Large Plant	200.000,	-180.000,
small plant	100.000,	-20.000,
do nothing	0,	0,

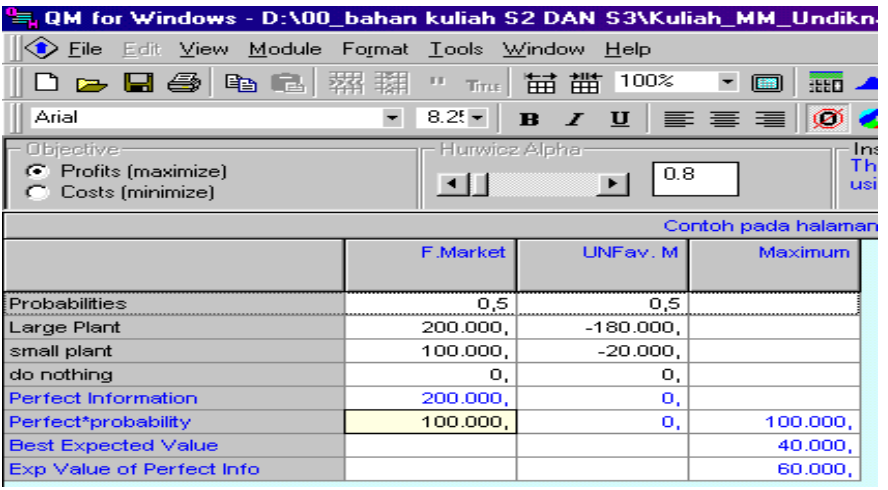
Hasil analisis sbb :



	F.Market	UNFav. M	EMV	Row Min	Row Max	Hurwicz
Probabilities	0,5	0,5				
Large Plant	200.000,	-180.000,	10.000,	-180.000,	200.000,	124.000,
small plant	100.000,	-20.000,	40.000,	-20.000,	100.000,	76.000,
do nothing	0,	0,	0,	0,	0,	0,
		maximum	40.000,	0,	200.000,	124.000,
			Best EV	maximin	maximax	Best

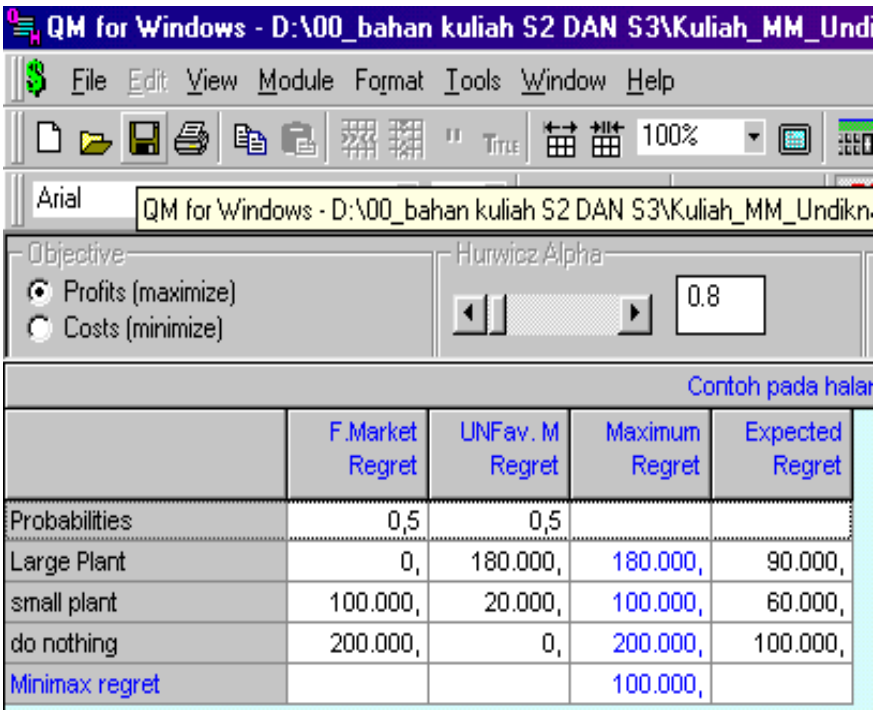
The maximum expected monetary value is 40.000 given by small plant
The maximin is 0 given by do nothing
The maximax is 200.000 given by Large Plant

Expected value of Perfect information (EVPI) sbb :



	F.Market	UNFav. M	Maximum
Probabilities	0,5	0,5	
Large Plant	200.000,	-180.000,	
small plant	100.000,	-20.000,	
do nothing	0,	0,	
Perfect Information	200.000,	0,	
Perfect*probability	100.000,	0,	100.000,
Best Expected Value			40.000,
Exp Value of Perfect Info			60.000,

Minimum Regret (Expected Opportunity LOSS – EOL)sbb :



	F.Market Regret	UNFav. M Regret	Maximum Regret	Expected Regret
Probabilities	0,5	0,5		
Large Plant	0,	180.000,	180.000,	90.000,
small plant	100.000,	20.000,	100.000,	60.000,
do nothing	200.000,	0,	200.000,	100.000,
Minimax regret			100.000,	

Small Plant menghasilkan regret (penyesalan yang terkecil) jika large plant dengan the best alternative tidak terpilih (p88 pada text).

Jika dikerjakan dengan QM-Excel sbb :

Microsoft Excel - Book1

File Edit View Insert Format Tools Data QM Window Help

A9 = Decision 1

	A	B	C	D	E	F	G	H	I
1	**Contoh halaman 86**								
2									
3	**Decision Tables**								
4		**Enter the profits or costs in the main body of the data table. Enter probabilities in the first**							
5		**row if you want to compute the expected value.**							
6	**Data**				**Results**				
7	Profit	Scenario 1	Scenario 2		EMV	Minimum	Maximum		
8	Probability	0,5	0,5						
9	Decision 1	200000	-180000		10000	-180000	200000		
10	Decision 2	100000	-20000		40000	-20000	100000		
11	Decision 3	0	0		0	0	0		
12				**Maximum**	**40000**	**0**	**200000**		
13									
14	**Expected Value of Perfect Information**								
15	Column best	200000	0		100000	<-Expected value under certainty			
16					40000	<-Best expected value			
17					60000	<-Expected value of perfect information			

19	Regret								
20		Scenario 1	Scenario 2		Expected	Maximum			
21	Probability	0,5	0,5						
22	Decision 1	0	180000		90000	180000			
23	Decision 2	100000	20000		60000	100000			
24	Decision 3	200000	0		100000	200000			
25				**Minimum**	**60000**	**100000**			
26									

1.3. Decision Trees

Lihat contoh p81-2006 , sbb :

Any problem that can be presented in a decision table can also be graphically illustrated in a *decision tree*. Let's take another look at the Thompson Lumber Company case first presented in Chapter 3. You may recall that John Thompson was trying to decide whether to expand his operation by building a new plant to produce storage sheds. A simple decision tree to represent John's decision is shown in Figure 4.1. Note that the tree presents the decision and outcomes in a sequential order. First, John decides whether to construct a large plant, a small plant, or no plant. Then, once that decision is made, the possible states of nature or outcomes (favorable or unfavorable market) will occur.

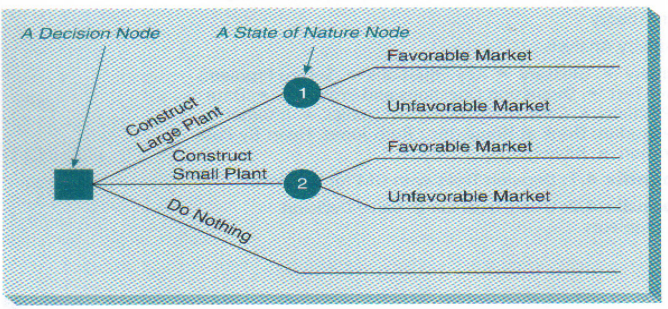
All decision trees are similar in that they contain *decision points* or *nodes* and *state-of-nature points* or *nodes*. These symbols are:

- □ A decision node from which one of several alternatives may be chosen
- ○ A state-of-nature node out of which one state of nature will occur

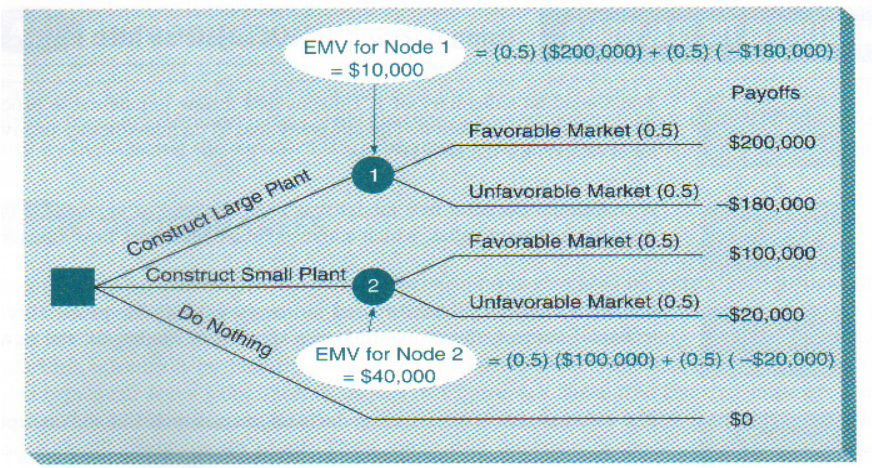
Analyzing problems with decision trees involves five steps:

Five Steps of Decision Tree Analysis

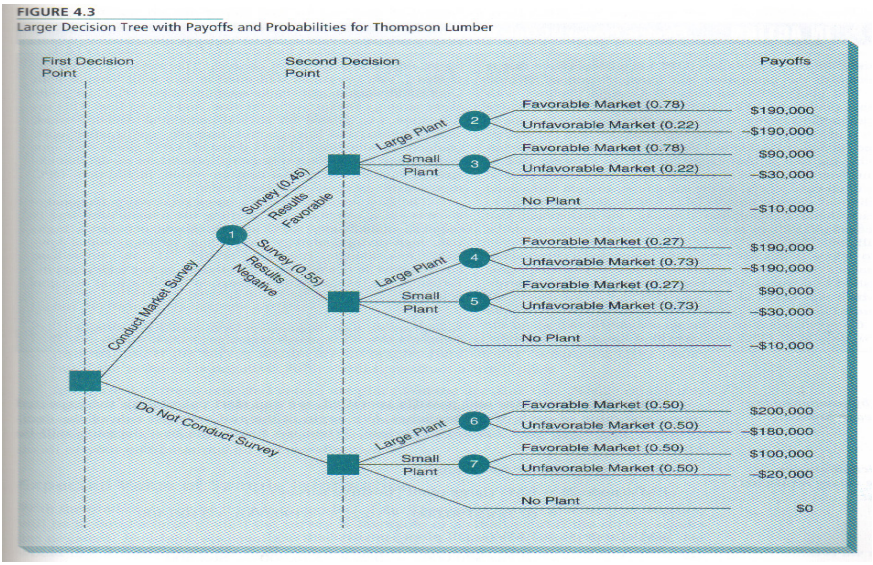
1. Define the problem.
2. Structure or draw the decision tree.
3. Assign probabilities to the states of nature.
4. Estimate payoffs for each possible combination of alternatives and states of nature.
5. Solve the problem by computing expected monetary values (EMVs) for each state of nature node. This is done by working backward, that is, starting at the right of the tree and working back to decision nodes on the left.



Penyelesaian decision tree sbb – P85-2006 :

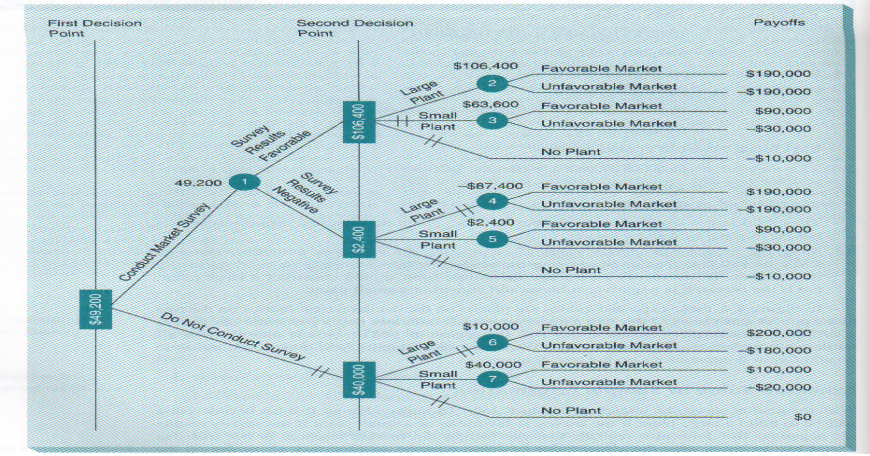


Contoh yang lebih complex sbb :



Menghasilkan keputusan sbb :

FIGURE 4.4
Thompson's Decision Tree with EMVs Shown



$106,400 diperoleh dari : (190,000*.78) – ((1-.78)*-190,000) = 148,200 –41,800 =106,400

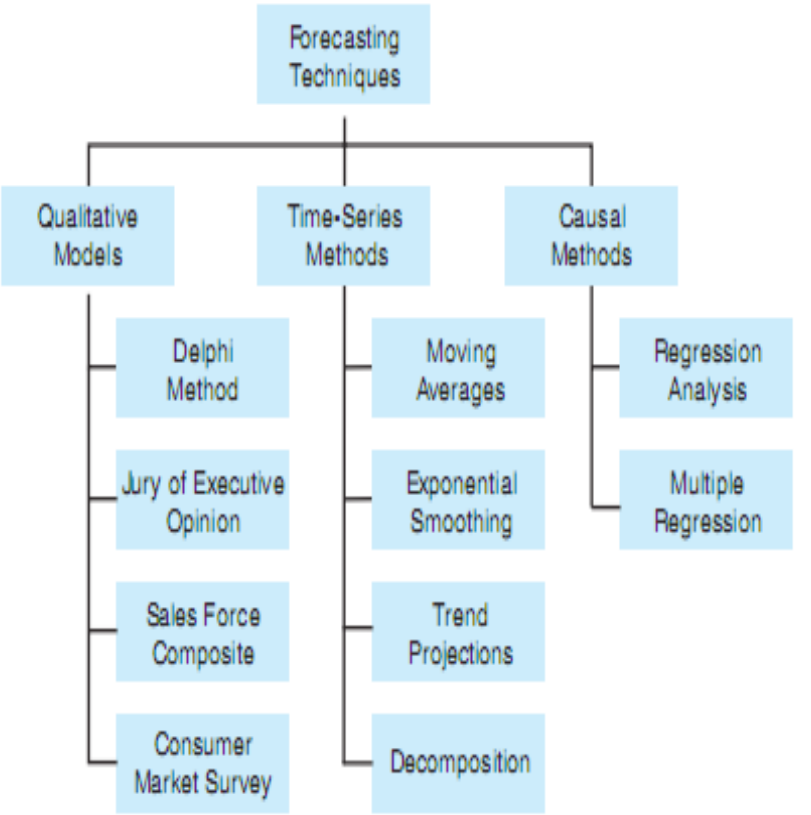
Kerjakan halaman 104-105

Bab 03 FORECASTING

Teknik Forcasing yang dapat dipergunakan a.l. :

- **Qualitative**
- **Time Series, dan**
- **Causal methods**

Perhatikan gambar berikut (p155, 2012)



1.4. Contoh Model Moving (MA) average 3 periode (MA3)

Jika kita mempunyai data selama 12 bulan sbb :

	Actual Shed sales
January	10,
February	12,
March	13,
April	16,
May	19,
June	23,
July	26,
August	30,
September	28,
October	18,
November	16,
December	14,

Pertanyaannya : Berapa besar penjualan bula januari berikutnya ?

Dengan menggunakan MA (3) periode =

$$\text{Moving average forecast} = \frac{\text{Sum of demands in previous } n \text{ periods}}{n}$$

Mathematically, this is written as

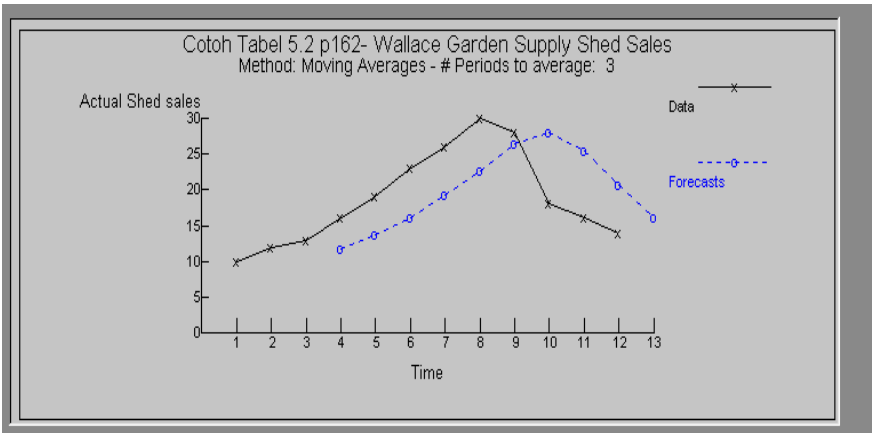
$$F_{t+1} = \frac{Y_t + Y_{t-1} + \cdots + Y_{t-n+1}}{n}$$

where

F_{t+1} = forecast for time period $t + 1$
Y_t = actual value in time period t
n = number of periods to average

Hasilnya adalah : (14 + 16 + 18) / 3 = 48 /3 = 16. (jika dengan QM-v4) hasilnya adalah :

	Actual Shed sales	Forecast	Error	|Error|	Error^2
January	10,				
February	12,				
March	13,				
April	16,	11,6667	4,3333	4,3333	18,7778
May	19,	13,6667	5,3333	5,3333	28,4444
June	23,	16,	7,	7,	49,
July	26,	19,3333	6,6667	6,6667	44,4444
August	30,	22,6667	7,3333	7,3333	53,7778
September	28,	26,3333	1,6667	1,6667	2,7778
October	18,	28,	-10,	10,	100,
November	16,	25,3333	-9,3333	9,3333	87,1111
December	14,	20,6667	-6,6667	6,6667	44,4445
TOTALS	225,		6,3333	58,3333	428,7777
AVERAGE	18,75		0,7037	6,4815	47,642
Next period forecast		16,	(Bias)	(MAD)	(MSE)
				Std err	7,8265



Baik tidaknya hasil forecast tergantung dari tingkat kesalahan yang terjadi dalam bentuk :

MAD = Mean Absolute deviation =

$$MAD = \frac{\sum |\text{forecast error}|}{n}$$

atau Mean Squared Error (MSE)

$$MSE = \frac{\sum (error)^2}{n}$$

atau Mean Absolute percent error (MAPE)

$$MAPE = \frac{\sum \left| \frac{error}{actual} \right|}{n} 100\%$$

(lihat, Stair, and Hanna, 2012, p158-159)

Pada gambar diatas terlihat masih ada Gap antara grafik actual dan Forecast, dan masih besarnya nilai MAD, dan MSE.

1.5. Contoh Exponential Smoothing –p163-2003 atau p160-2006

Metode forecast ini disusun dengan cara melakukan adjustment pada model forecast sebelumnya. Sehingga modelnya menjadi sbb:

New forecast = last period's forecast + α (last period's actual demand minus last period's forecast)

atau

$$F_{t+1} = \alpha A_t + (1-\alpha) F_t$$

dimana
nilai alpha di prediksi sebesar

$$\alpha = 2/(N+1)$$

N = # of periods of MA (Lihat Riggs, Operation management, 1976,p97)

	Actual Shed
January	10
February	12
March	13
April	16
May	19
June	23
July	26
August	30
September	28
October	18
November	16
December	14

Exponential Smoothing | .1 | Error analysis begins in period 2

Coloh Tabel 5.2 p162- Wallace Garden Supply Shed Sales Solutio

	Actual Shed sales	Forecast	Error	|Error|	Error^2
January	10,	10,			
February	12,	10,	2,	2,	4,
March	13,	10,2	2,8	2,8	7,84
April	16,	10,48	5,52	5,52	30,4704
May	19,	11,032	7,968	7,968	63,489
June	23,	11,8288	11,1712	11,1712	124,7957
July	26,	12,9459	13,0541	13,0541	170,409
August	30,	14,2513	15,7487	15,7487	248,0207
September	28,	15,8262	12,1738	12,1738	148,2015
October	18,	17,0436	0,9564	0,9564	0,9147
November	16,	17,1392	-1,1392	1,1392	1,2978
December	14,	17,0253	-3,0253	3,0253	9,1524
TOTALS	225,		67,2277	75,5567	808,5914
AVERAGE	18,75		6,1116	6,8688	73,5083
Next period forecast		16,7228	(Bias)	(MAD)	(MSE)
				Std err	9,4786

1.6. Model Regressi – p172 -2003 atau p120-2006 – Midwestern Manufacturing's Model Trend sbb :

$$\hat{Y} = b_0 + b_1 X$$

where

$\hat{Y}$ = predicted value
b_0 = intercept
b_1 = slope of the line
X = time period (i.e., $X = 1, 2, 3, \ldots, n$)

Jika data yang dipunyai sbb :

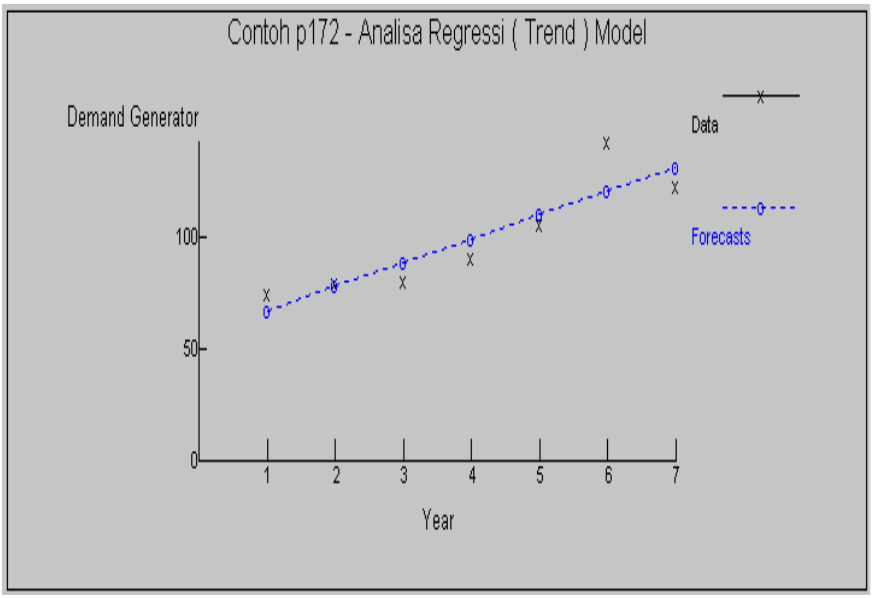
	Demand	Year
1993	74	1
1994	79	2
1995	80	3
1996	90	4
1997	105	5
1998	142	6
1999	122	7

Dengan menggunakan QM akan diperoleh sbb :

Contoh p172 - Analisa Regressi (Trend) Model Solution						
	Demand Generator	Year	Forecast	Error	|Error|	Error^2
1993	74,	1,	67,25	6,75	6,75	45,5625
1994	79,	2,	77,7857	1,2143	1,2143	1,4745
1995	80,	3,	88,3214	-8,3214	8,3214	69,2461
1996	90,	4,	98,8572	-8,8571	8,8571	78,4491
1997	105,	5,	109,3929	-4,3929	4,3929	19,2972
1998	142,	6,	119,9286	22,0714	22,0714	487,1479
1999	122,	7,	130,4643	-8,4643	8,4643	71,6443
TOTALS	4.180,	42.692,		0,	60,0714	772,8215
AVERAGE	597,1429	6.098,857		0,	8,5816	110,4031
				(Bias)	(MAD)	(MSE)
Betas	56,7143	10,5357			Std err	12,4324

Diperoleh hasil : Y = 56.7143 + 10.5357 * time (year 1 ... s/d 7)

Measure	Value
Error Measures	
Bias (Mean Error)	0,
MAD (Mean Absolute Deviation)	8,5816
MSE (Mean Squared Error)	110,4031
Standard Error (denom=n-2-0=5)	12,4324
Regression line	
Demand Generator = 56,7143	
+ 10,5357 * Year	
Statistics	
Correlation coefficient	0,8949
Coefficient of determination (r^2)	0,8009



Pertanyaan berapa nilai penjualan pada tahun 2000 s/d 2013 ?

Bab 04 INVENTORY CONTROL MODEL

Keputusan atas *Inventory Control* dapat meliputi :

- How much to order
- When to order – p192-2006

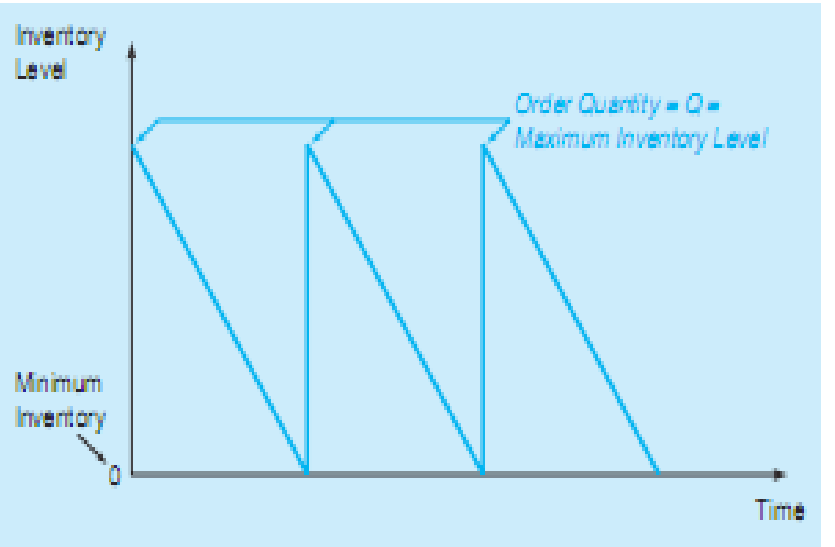
Tujuan utama dari 'control' ini adalah untuk meminimkan total inventory cost yang meliputi costs :

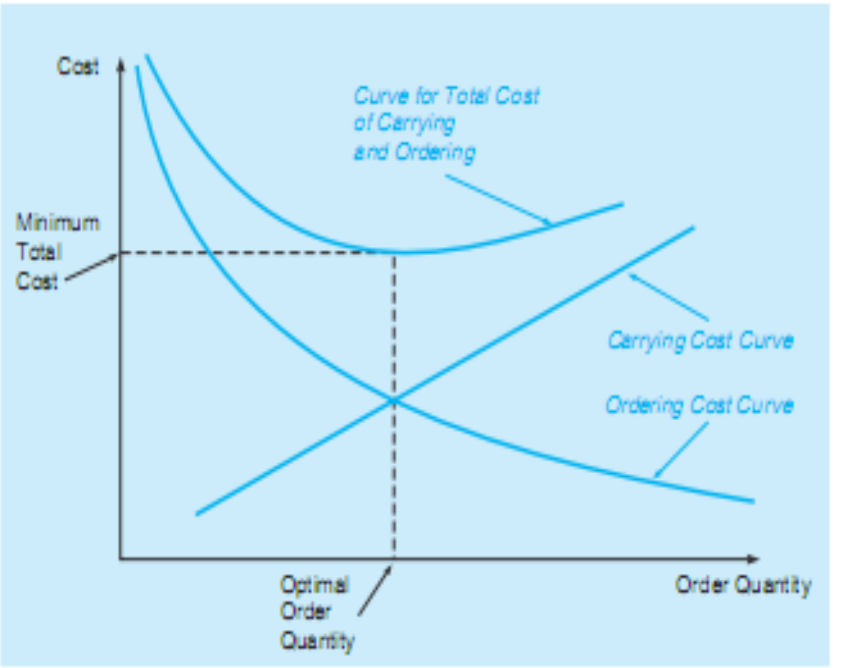
1. **Cost of items**
2. **Cost of ordering :**
   - **Develop & sending purchase order**
   - **Process & inspect incoming order**
   - **Bill paying**
   - **Inventories inquiries**
   - **Utilities, phone bill and soon for purchasing dept.**
   - **Salaries & wages for purchasing dept. employee**
   - **Supplies for prurchasing dept.**
3. **Cost of carrying or holding :**
   1. **Cost of capital**
   2. **Taxes**
   3. **Spoilage**
   4. **Theft**
   5. **Obsolescence**
   6. **Salaries & wages for warehouse employee**
   7. **Utilities & building cost for the warehouse**
   8. **Supplies for warehouse**
4. **Cost of stockout**

   Economic order Quantity (EOQ) – How much to order

Assumptions :

1. **Demand is known and constant**
2. **the lead time (time between to order up to receipt) is known and constant**
3. **Quantity discount is not possible**
4. **only cost to order & carriyng are variable**
5. **the reciept of inventory is instantaneous**
6. **if orders are palced at rthe right time, stockout or shartage can be avoided completely**





(lihat p200-2012, Render, Stair and Hanna)

$$\text{Annual holding cost} = \text{Annual ordering cost}$$

$$\frac{Q}{2}C_h = \frac{D}{Q}C_o$$

Solving this for Q gives the optimal order quantity:

$$Q^2 C_h = 2DC_o$$

$$Q^2 = \frac{2DC_o}{C_h}$$

$$Q = \sqrt{\frac{2DC_o}{C_h}}$$

This optimal order quantity is often denoted by Q^*. Thus, the economic order quantity is given by the following formula:

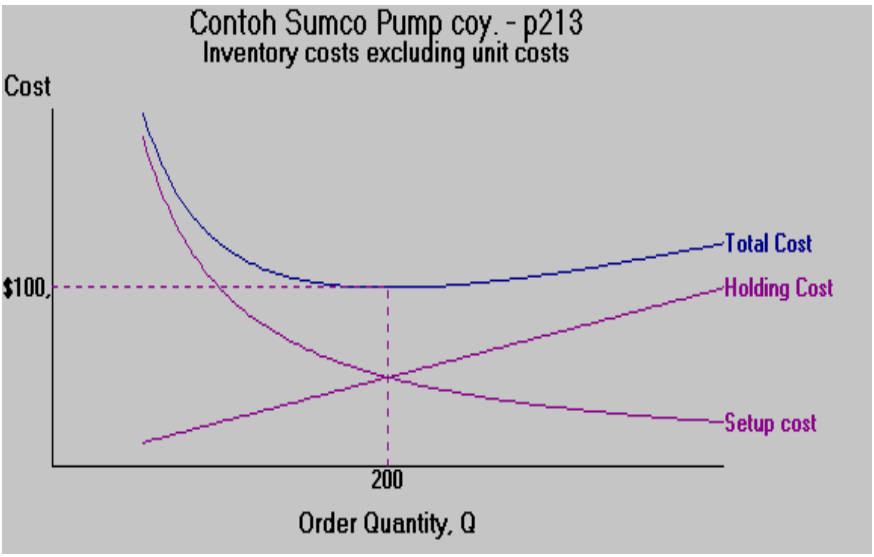
$$\text{EOQ} = Q^* = \sqrt{\frac{2DC_o}{C_h}}$$

Misalkan Demand (D) = 1000; Order Cost = 10 ; dan Holding Cost 0.5 (,(see p213-2003 atau p197-2006) maka EOQ adalah sbb

Inventory Results

Contoh Sumco Pump coy. - p213 Solution

PARAMETER	VALUE		PARAMETER	VALUE
Demand rate(D)	1000		Optimal order quantity (Q*)	200,
Setup/Ordering cost(S)	10		Maximum Inventory Level	200,
Holding cost(H)	,5		Average inventory	100,
Unit cost	0		Orders per period(year)	5,
			Annual Setup cost	50,
			Annual Holding cost	50,
			Unit costs (PD)	0,
			Total Cost	100,



Bab 05 LINEAR PROGRAMMING

Contoh – p256-2003 atau p256-2006 – Flair Furniture Company data.

Misalkan perusahaan ini akan memproduksi meja (x1) dan kursi (x2) dengan waktu penyelesaiaan setiap produk tersebut pada bagian / departemen pertukangan (carpentary – dalam jam per produk) terlihat sebagai berikut :

Dept.	Tables (x1)	Chairs (x2)	Available Hours this week (waktu yang tersedia per departemen setiap minggu – dalam jam)
Carpentry	4	3	240
Painting & Varnishing	2	1	100
Profit per unit	$5	$7	

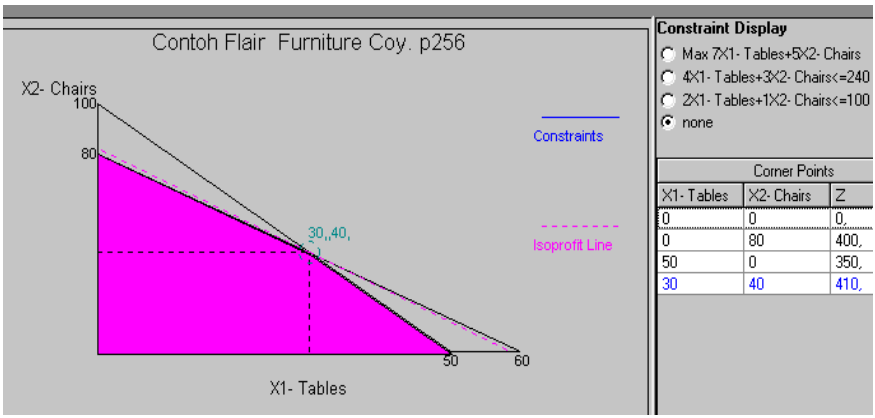
Hasil yang diperoleh adalah :

Linear Programming Results

Contoh Flair Furniture Coy. p256 solution					
	X1- Tables	X2- Chairs		RHS	Dual
Maximize	7,	5,			
Carpentry	4,	3,	<=	240,	1,5
Painting	2,	1,	<=	100,	0,5
Solution->	30,	40,		$410,	

Ranging

Contoh Flair Furniture Coy. p256 solution					
Variable	Value	Reduced Cost	Original Val	Lower Bound	Upper Bound
X1- Tables	30,	0,	7,	6,67	10,
X2- Chairs	40,	0,	5,	3,5	5,25
Constraint	Dual Value	Slack/Surplus	Original Val	Lower Bound	Upper Bound
Carpentry	15,	0,	240,	200,	300,
Painting	.5	0,	100,	80,	120,



Hasil yang diperoleh adalah : X1 = 40 dan X2 = 40 dan Profit yang diperoleh $ 410.

Jika perusahaan dapat meningkatkan waktu / jam carpentary 1 jam lagi maka profit akan naik $ 1.5, silahkan mencoba.

Contoh p306 -2003 atau p294-2006– Media selection- Marketing application

8.2 MARKETING APPLICATIONS

Media Selection

Linear programming models have been used in the advertising field as a decision aid in selecting an effective media mix. Sometimes the technique is employed in allocating a fixed or limited budget across various media, which might include radio or television commercials, newspaper ads, direct mailings, magazine ads, and so on. In other applications, the objective is the maximization of audience exposure. Restrictions on the allowable media mix might arise through contract requirements, limited media availability, or company policy. An example follows.

The Win Big Gambling Club promotes gambling junkets from a large midwestern city to casinos in the Bahamas. The club has budgeted up to $8,000 per week for local advertising. The money is to be allocated among four promotional media: TV spots, newspaper ads, and two types of radio advertisements. Win Big's goal is to reach the largest possible high-potential audience through the various media. The following table presents the number of potential gamblers reached by making use of an advertisement in each of the four media. It also provides the cost per advertisement placed and the maximum number of ads that can be purchased per week.

MEDIUM	AUDIENCE REACHED PER AD	COST PER AD ($)	MAXIMUM ADS PER WEEK
TV spot (1 minute)	5,000	800	12
Daily newspaper (full-page ad)	8,500	925	5
Radio spot (30 seconds, prime time)	2,400	290	25
Radio spot (1 minute, afternoon)	2,800	380	20

Win Big's contractual arrangements require that at least five radio spots be placed each week. To ensure a broad-scoped promotional campaign, management also insists that no more than $1,800 be spent on radio advertising every week.

The problem can now be stated mathematically as follows. Let

X_1 = number of 1-minute TV spots taken each week

X_2 = number of full-page daily newspaper ads taken each week

X_3 = number of 30-second prime-time radio spots taken each week

X_4 = number of 1-minute afternoon radio spots taken each week

Objective:

maximize audience coverage $= 5{,}000X_1 + 8{,}500X_2 + 2{,}400X_3 + 2{,}800X_4$

subject to

$X_1 \leq 12$ (maximum TV spots/week)

$X_2 \leq 5$ (maximum newspaper ads/week)

$X_3 \leq 25$ (maximum 30-second radio spots/week)

$X_4 \leq 20$ (maximum 1-minute radio spots/week)

$800X_1 + 925X_2 + 290X_3 + 380X_4 \leq \$8{,}000$ (weekly advertising budget)

$X_3 + X_4 \geq 5$ (minimum radio spots contracted)

$290X_3 + 380X_4 \leq \$1{,}800$ (maximum dollars spent on radio)

The solution to this LP formulation, using Excel's Solver (see Programs 8.1A and 8.1B), is found to be

$X_1 = 1.97$ TV spots

$X_2 = 5$ newspaper ads

$X_3 = 6.2$ 30-second radio spots

$X_4 = 0$ one-minute radio spots

This produces an audience exposure of 67,240 contacts. Because X_1 and X_3 are fractional, Win Big would probably round them to 2 and 6, respectively. Problems that demand all-integer solutions are discussed in detail in Chapter 11.

Dengan QM hasilnya sebagai berikut :

(untitled)						
	X1- TV Spots	X2- X2-News	X3-30sec radio	X4-one min rdio		RHS
Maximize	5.000	8.500	2.400	2.800		
Max Tv spot per week	1				<=	12
Max Newsapers ads per week		1			<=	5
max 30 sec radio spot per week			1		<=	25
max 1 min radio spot per week				1	<=	20
Budget per week	800	925	290	380	<=	8.000
Min radio spots contracted			1	1	>=	5
Maximum dollar spent on radio			290	380	<=	1.800

Variable	Status	Value
X1- TV Spots	Basic	1,9688
X2- X2-News ads	Basic	5,
X3-30sec radio	Basic	6,2069
X4-one min rdio	NONBasic	0,
slack 1	Basic	10,0313
slack 2	NONBasic	0,
slack 3	Basic	18,7931
slack 4	Basic	20,
slack 5	NONBasic	0,
surplus 6	Basic	1,2069
slack 7	NONBasic	0,
Optimal Value (Z)		67.240,3

Linear Programming Results

(untitled) Solution

	X1- TV Spots	X2- X2-News ads	X3-30sec radio	X4-one min rdio		RHS	Dual
Maximize	5.000,	8.500,	2.400,	2.800,			
Max Tv spot per week	1,				<=	12,	0,
Max Newsapers ads per week		1,			<=	5,	2.718,75
max 30 sec radio spot per week			1,		<=	25,	0,
max 1 min radio spot per week				1,	<=	20,	0,
Budget per week	800,	925,	290,	380,	<=	8.000,	6,25
Min radio spots contracted			1,	1,	>=	5,	0,
Maximum dollar spent on radio			290,	380,	<=	1.800,	2,0259
Solution->	1,9688	5,	6,2069	0,		$67.240,3	

Ranging

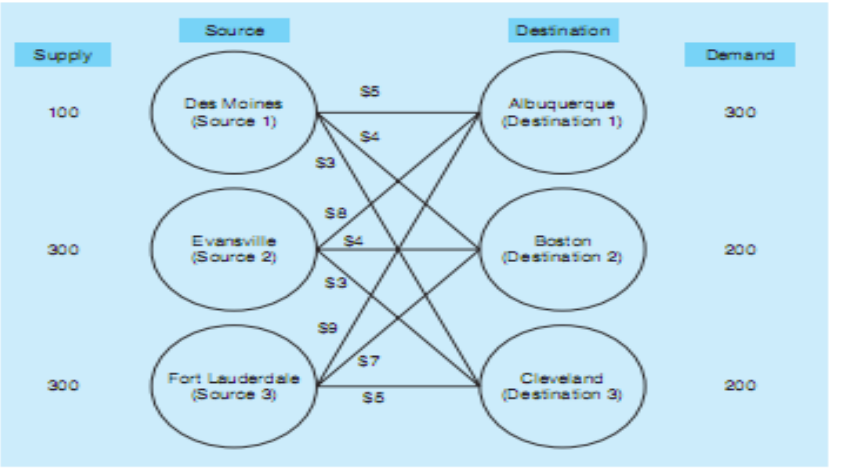
(untitled) Solution

Variable	Value	Reduced Cost	Original Val	Lower Bound	Upper Bound
X1- TV Spots	1,97	0,	5.000,	0,	6.620,69
X2- X2-News ads	5,	0,	8.500,	5.781,25	Infinity
X3-30sec radio	6,21	0,	2.400,	2.136,84	Infinity
X4-one min rdio	0,	344,8276	2.800,	-Infinity	3.144,83
Constraint	**Dual Value**	**Slack/Surplus**	**Original Val**	**Lower Bound**	**Upper Bound**
Max Tv spot per week	0,	10,0313	12,	1,97	Infinity
Max Newsapers ads per week	271.875,	0,	5,	0,	6,7
max 30 sec radio spot per week	0,	18,7931	25,	6,21	Infinity
max 1 min radio spot per week	0,	20,	20,	0,	Infinity
Budget per week	625,	0,	8.000,	6.425,	16.025,
Min radio spots contracted	0,	1,2069	5,	-Infinity	6,21
Maximum dollar spent on radio	2.025.862,	0,	1.800,	1.450,	3.375,

Kerjakan p284-285-2006
Sensitivity analisys – p380-381 -2006

Bab 06 TRANSPORTATION PROBLEM

Problema Transportasi adalah masalah pendistribusian barang / produk dari sumbernya ke daerah yang meminta produk tersebut. Misalkan pada contoh hal 342, tahun 2012, terlihat kapasitas supply dan demand dari masing masing daerah, serta biaya transportasi per km / unit barang yang akan dipindahkan.



Jika dikerjakan dengan Linear Programming :

The LP formulation is

$$\text{Minimize total cost} = 5X_{11} + 4X_{12} + 3X_{13} + 8X_{21} + 4X_{22} + 3X_{23} + 9X_{31} + 7X_{32} + 5X_{33}$$

subject to

$$X_{11} + X_{12} + X_{13} \leq 100 \quad \text{(Des Moines supply)}$$
$$X_{21} + X_{22} + X_{23} \leq 300 \quad \text{(Evansville supply)}$$
$$X_{31} + X_{32} + X_{33} \leq 300 \quad \text{(Fort Lauderdale supply)}$$
$$X_{11} + X_{21} + X_{31} = 300 \quad \text{(Albuquerque demand)}$$
$$X_{12} + X_{22} + X_{32} = 200 \quad \text{(Boston demand)}$$
$$X_{13} + X_{23} + X_{33} = 200 \quad \text{(Cleveland demand)}$$
$$X_{ij} \geq 0 \text{ for all } i \text{ and } j$$

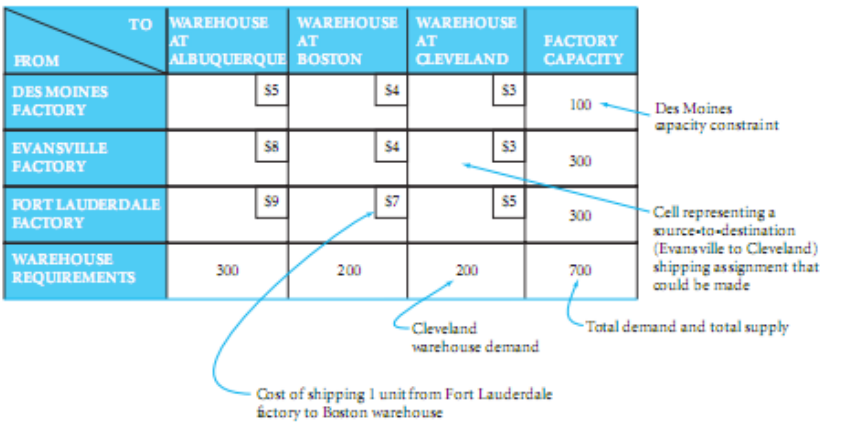
where

i = 1, 2, 3, with 1 = Des Moines, 2 = Evansville, and 3 = Fort Lauderdale

j = 1, 2, 3, with 1 = Albuquerque, 2 = Boston, and 3 = Cleveland

Cara menyelesaikan masalah transportasi dapat dilakukan sbb :

Intial Solution	Final Solution
1) Northwest Corner rule– (p411,2006)	1) Stepping stone method-p413
2) Least cost	2) Modified method-p421: Cij = Ri + Kj Improved Index (Iij= Cij – Ri-Kj) (lihat p421-2003 atau p408-2006)
3) Vogel's approximation metod-p424	



Penyelesaian dengan QM :

Objective
Maximize
Minimize

Starting method
Any starting method
Any starting method
Northwest Corner Method
Minimum Cost Method
Vogel's Approximation Method

Instruction
Choose the method

Factory_Warehouses

	To Albuqueque	To Boston	To Cleveland	SUPPLY
Source 1 - Des Moines	5	4	3	100
Source 2 - Evansville	8	4	3	300
Source 3 - Fort Lauderdale	9	7	5	300
DEMAND	300	200	200	

Transportation Shipments

Optimal cost = $3.900	To Albuqueque	To Boston	To Cleveland
	Contoh Executive Furniture's Factory		
Source 1 - Des Moines	100,		
Source 2 - Evansville		200,	100,
Source 3 - Fort Lauderdale	200,		100,

Shipments with costs

	To Albuqueque	To Boston	To Cleveland
	Contoh Executive Furniture's Factory Warehouse		
Source 1 - Des Moines	100/$500		
Source 2 - Evansville		200/$800	100/$300
Source 3 - Fort Lauderdale	200/$1800		100/$500

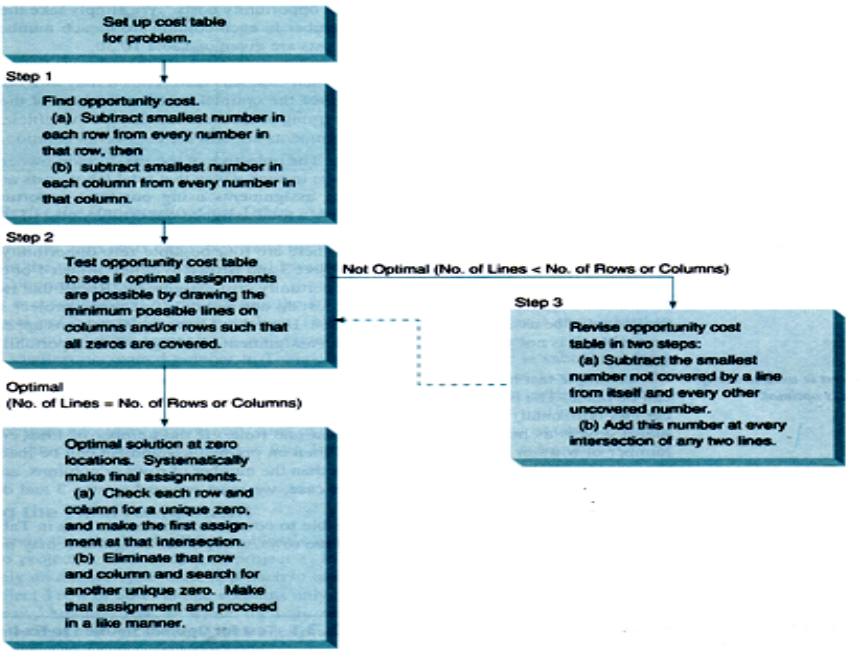
Shipping list

Contoh Executive Furniture's Factory_Warehouses - p410 solution

From	To	Shipment	Cost per unit	Shipment cost
Source 1 - Des Moines	To Albuquerque	100	5	500
Source 2 - Evansville	To Boston	200	4	800
Source 2 - Evansville	To Cleveland	100	3	300
Source 3 - Fort Lauderdale	To Albuquerque	200	9	1.800
Source 3 - Fort Lauderdale	To Cleveland	100	5	500

Bab 07 ASSIGNMENT METHOD

Prosedure penyelesaian pembagian tugas sbb : (see p421-2006):

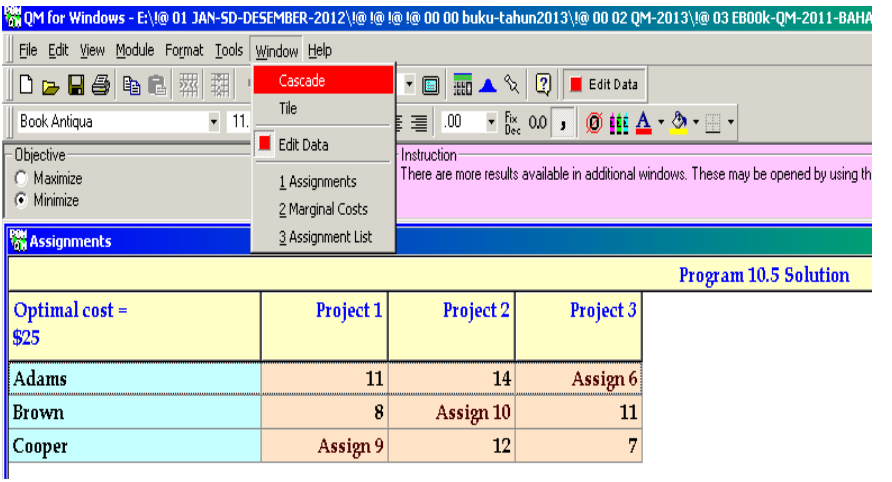


Misalkan kita mempunyai 3 (tiga) orang yang akan di beri tugas pada 3 (tiga) project, dengan biaya masing masing terlihat sbb :

PERSON	PROJECT		
	1	2	3
Adams	$11	$14	$6
Brown	8	10	11
Cooper	9	12	7

Tentukanlah siapa yang akan bertugas apa dengan biaya yang paling minimal (see, p366, 2012)

	Project 1	Project 2	Project 3
Adams	11	14	6
Brown	8	10	11
Cooper	9	12	7



Assignment List

JOB	Assigned to	Cost
Adams	Project 3	6
Brown	Project 2	10
Cooper	Project 1	9
Total		25

Bab 08 SIMULATION MODEL

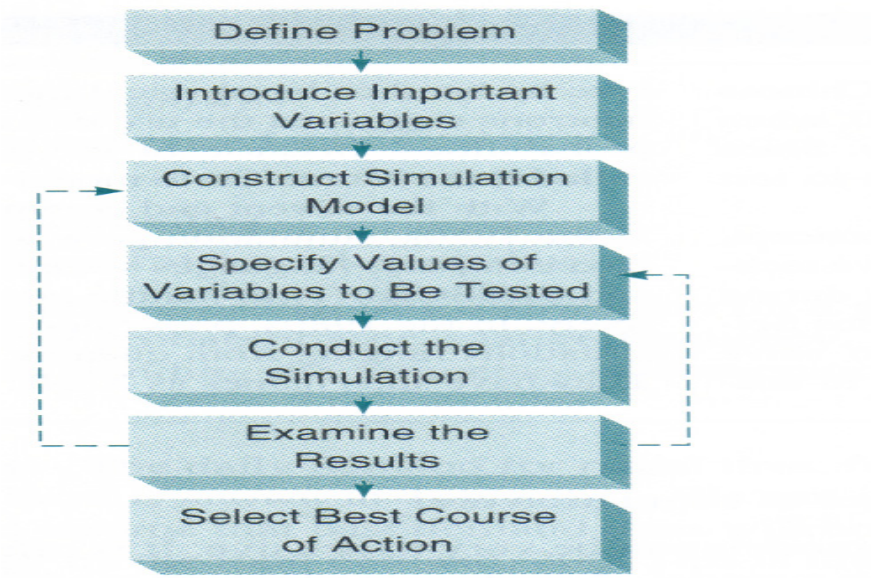
Simulasi akan digunakan ketika tingkat probabilitas sesuatu kejadian tidak dapat diprediksi.

Misalkan kita ingin memprediksi penjualan ban mobil 10 (sepuluh) hari kedepan.

Data Penjualan Ban mobil selama setahun (200 hari kerja) sebagai berikut :

DEMAND FOR TIRES	FREQUENCY (DAYS)	PROBABILITY OF OCCURRENCE
0	10	10/200 = 0.05
1	20	20/200 = 0.10
2	40	40/200 = 0.20
3	60	60/200 = 0.30
4	40	40/200 = 0.20
5	30	30/200 = 0.15
	200	200/200 = 1.00

Untuk menyelesaikan permasalah ini dilakukan *7 **steps pada model simulasi sbb :*** **(contoh Monte Carlo simulation p658-2003 atau p607-2006)**



Contoh :

Perusahaan penjualan ban mobil Harry selama 200 hari permintaan ban mobil dapat dikalsifikasikan sebagai berikut (see p612-2006): ke tujuh langkah tersebut adalah :

Step 1. **Step 2**

TABLE 15.1 Historical Daily Demand for Radial Tires at Harry's Auto Tire

DEMAND FOR TIRES	FREQUENCY (DAYS)
0	10
1	20
2	40
3	60
4	40
5	30
	200

TABLE 15.2 Probability of Demand for Radial Tires

DEMAND VARIABLE	PROBABILITY OF OCCURRENCE
0	10/200 = 0.05
1	20/200 = 0.10
2	40/200 = 0.20
3	60/200 = 0.30
4	40/200 = 0.20
5	30/200 = 0.15
	200/200 = 1.00

Step 3.

TABLE 15.3 Cumulative Probabilities for Radial Tires

DAILY DEMAND	PROBABILITY	CUMULATIVE PROBABILITY
0	0.05	0.05
1	0.10	0.15
2	0.20	0.35
3	0.30	0.65
4	0.20	0.85
5	0.15	1.00

Step 4 – menentukan interval random number

TABLE 15.4 Assignment of Random Number Intervals for Harry's Auto Tire

DAILY DEMAND	PROBABILITY	CUMULATIVE PROBABILITY	INTERVAL OF RANDOM NUMBERS
0	0.05	0.05	01 to 05
1	0.10	0.15	06 to 15
2	0.20	0.35	16 to 35
3	0.30	0.65	36 to 65
4	0.20	0.85	66 to 85
5	0.15	1.00	86 to 00

Step 5. – Mencari angka random pada tabel random

TABLE 15.5 Table of Random Numbers

52	06	50	88	53	30	10	47	99	37	66	91	35	32	00	84	57	07
37	63	28	02	74	35	24	03	29	60	74	85	90	73	59	55	17	60
82	57	68	28	05	94	03	11	27	79	90	87	92	41	09	25	36	77
69	02	36	49	71	99	32	10	75	21	95	90	94	38	97	71	72	49
98	94	90	36	06	78	23	67	89	85	29	21	25	73	69	34	85	76
96	52	62	87	49	56	59	23	78	71	72	90	57	01	98	57	31	95
33	69	27	21	11	60	95	89	68	48	17	89	34	09	93	50	44	51
50	33	50	95	13	44	34	62	64	39	55	29	30	64	49	44	30	16
88	32	18	50	62	57	34	56	62	31	15	40	90	34	51	95	26	14
90	30	36	24	69	82	51	74	30	35	36	85	01	55	92	64	09	85
50	48	61	18	85	23	08	54	17	12	80	69	24	84	92	16	49	59
27	88	21	62	69	64	48	31	12	73	02	68	00	16	16	46	13	85
45	14	46	32	13	49	66	62	74	41	86	98	92	98	84	54	33	40
81	02	01	78	82	74	97	37	45	31	94	99	42	49	27	64	89	42
66	83	14	74	27	76	03	33	11	97	59	81	72	00	64	61	13	52
74	05	81	82	93	09	96	33	52	78	13	06	28	30	94	23	37	39
30	34	87	01	74	11	46	82	59	94	25	34	32	23	17	01	58	73
59	55	72	33	62	13	74	68	22	44	42	09	32	46	71	79	45	89
67	09	80	98	99	25	77	50	03	32	36	63	65	75	94	19	95	88
60	77	46	63	71	69	44	22	03	85	14	48	69	13	30	50	33	24
60	08	19	29	36	72	30	27	50	64	85	72	75	29	87	05	75	01
80	45	86	99	02	34	87	08	86	84	49	76	24	08	01	86	29	11
53	84	49	63	26	65	72	84	85	63	26	02	75	26	92	62	40	67
69	84	12	94	51	36	17	02	15	29	16	52	56	43	26	22	08	62
37	77	13	10	02	18	31	19	32	85	31	94	81	43	31	58	33	51

Source: Excerpted from *A Million Random Digits with 100,000 Normal Deviates* (New York: Free Press, 1955), p. 7, with permission of the Rand Corporation.

Step 6 – memprediksi dengan acak permintaan 10 hari yang akan datang – dan rata-rata perhari 10 hari yad

TABLE 15.6 Ten-Day Simulation of Demand for Radial Tires

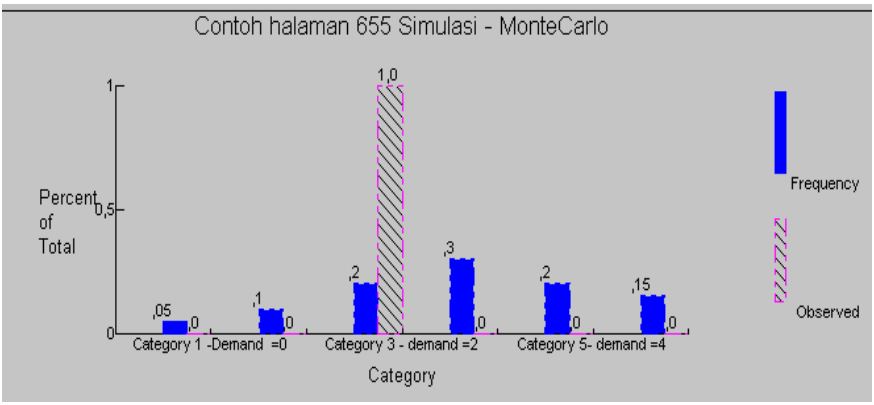
DAY	RANDOM NUMBER	SIMULATED DAILY DEMAND
1	52	3
2	37	3
3	82	4
4	69	4
5	98	5
6	96	5
7	33	2
8	50	3
9	88	5
10	90	5
		39 = total 10-day demand
		3.9 = average daily demand for tires

Dengan menggunakan QM diperoleh sbb :

Simulation Results

Contoh halaman 655 Simulasi - MonteCarlo Solution

Category name	Value	Frequency	Probability	Cumulative Probability	Value * Frequency	ccurrences	ercentage	ccurences * Value
Category 1 -Demand =0	0,	10,	0,05	0,05	0,	0,	0,	0,
Category 2- Demand = 1	1,	20,	0,1	0,15	0,1	0,	0,	0,
Category 3 - demand =2	2,	40,	0,2	0,35	0,4	1,	1,	2,
Category 4- demand =3	3,	60,	0,3	0,65	0,9	0,	0,	0,
Category 5- demand =4	4,	40,	0,2	0,85	0,8	0,	0,	0,
Category 6 - demand	5,	30,	0,15	1,	0,75	0,	0,	0,
Total		200,	1,	Expected	2,95	1,	1,	2,
							Average	2,


Contoh halaman 655 Simulasi - MonteCarlo
Percent of Total
1
0,5
0
,05
,0
,1
,0
,2
1,0
,3
,0
,2
,0
,15
,0
Category 1 -Demand =0
Category 3 - demand =2
Category 5- demand =4
Category
Frequency
Observed

Bab 09 PROJECT MANAGEMENT

a. 6 (enam) langkah (steps) PERT & CPM (see p526-2006)

Six Steps of PERT and CPM

1. Define the project and all of its significant activities or tasks.
2. Develop the relationships among the activities. Decide which activities must precede and follow others.
3. Draw the network connecting all of the activities.
4. Assign time and/or cost estimates to each activity.
5. Compute the longest time path through the network; this is called the *critical path*.
6. Use the network to help plan, schedule, monitor, and control the project.

b. Hal – hal yang perlu dijawab pada PERT model

Almost any large project can be subdivided into a series of smaller activities or tasks that can be analyzed with PERT. When you recognize that projects can have thousands of specific activities, you see why it is important to be able to answer such questions as the following:

1. When will the entire project be completed?
2. What are the *critical* activities or tasks in the project, that is, the ones that will delay the entire project if they are late?
3. Which are the *noncritical* activities, that is, the ones that can run late without delaying the entire project's completion?
4. What is the probability that the project will be completed by a specific date?
5. At any particular date, is the project on schedule, behind schedule, or ahead of schedule?
6. On any given date, is the money spent equal to, less than, or greater than the budgeted amount?
7. Are there enough resources available to finish the project on time?
8. If the project is to be finished in a shorter amount of time, what is the best way to accomplish this at the least cost?

PERT (or PERT/Cost) can help answer each of these questions.

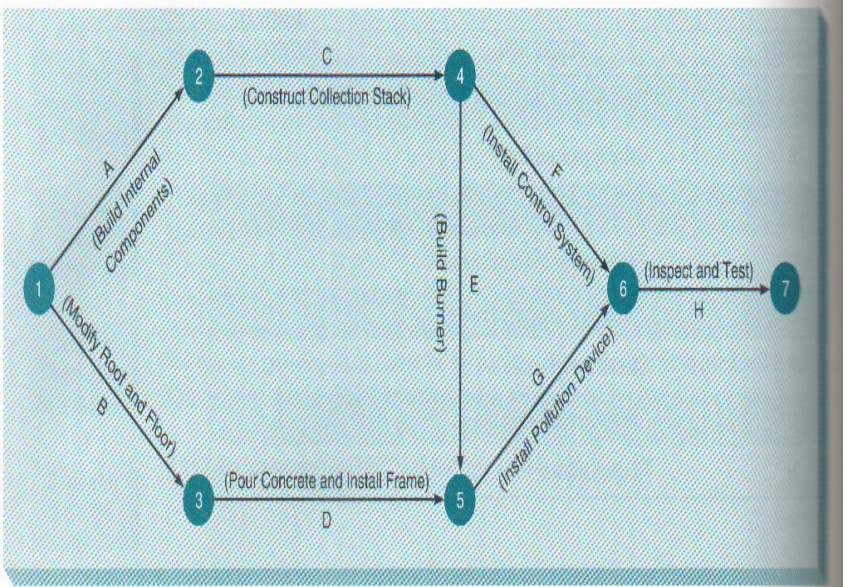
Contoh – hal 571 – 2003 atau 531-2006

TABLE 13.1 Activities and Immediate Predecessors for General Foundry, Inc.

ACTIVITY	DESCRIPTION	IMMEDIATE PREDECESSORS
A	Build internal components	—
B	Modify roof and floor	—
C	Construct collection stack	A
D	Pour concrete and install frame	B
E	Build high-temperature burner	C
F	Install control system	C
G	Install air pollution device	D, E
H	Inspect and test	F, G

c. Cara menggambarkan PERT

FIGURE 13.1
Network for General Foundry, Inc.



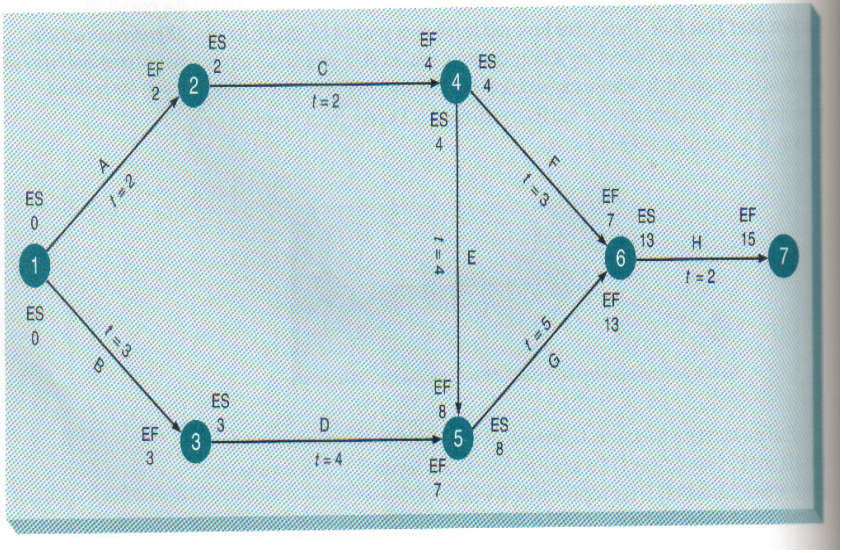
d. Menentukan waktu penyelesaian

TABLE 13.2 Time Estimates (Weeks) for General Foundry, Inc.

ACTIVITY	OPTIMISTIC, a	MOST PROBABLE, m	PESSIMISTIC, b	EXPECTED TIME, $t = [(a + 4m + b)/6]$	VARIANCE, $[(b - a)/6]^2$
A	1	2	3	2	$\left(\frac{3-1}{6}\right)^2 = \frac{4}{36}$
B	2	3	4	3	$\left(\frac{4-2}{6}\right)^2 = \frac{4}{36}$
C	1	2	3	2	$\left(\frac{3-1}{6}\right)^2 = \frac{4}{36}$
D	2	4	6	4	$\left(\frac{6-2}{6}\right)^2 = \frac{16}{36}$
E	1	4	7	4	$\left(\frac{7-1}{6}\right)^2 = \frac{36}{36}$
F	1	2	9	3	$\left(\frac{9-1}{6}\right)^2 = \frac{64}{36}$
G	3	4	11	5	$\left(\frac{11-3}{6}\right)^2 = \frac{64}{36}$
H	1	2	3	2	$\left(\frac{3-1}{6}\right)^2 = \frac{4}{36}$
				25	

e. Menghitung waktu kritis

FIGURE 13.4
General Foundry's Earliest Start (ES) and Earliest Finish (EF) Times



f. Menghitung probabilitas penyelesaian project

From Table 13.2 we know that

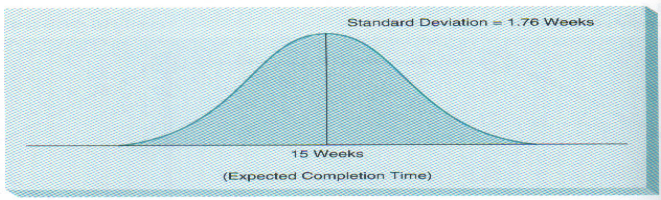
CRITICAL ACTIVITY	VARIANCE
A	1/36
C	1/36
E	36/36
G	64/36
H	1/36

Hence the project variance is

$$\text{project variance} = 1/36 + 1/36 + 36/36 + 64/36 + 1/36 = 112/36 = 3.111$$

We know that the standard deviation is just the square root of the variance, so

$$\text{project standard deviation} = \sigma_T = \sqrt{\text{project variance}}$$
$$= \sqrt{3.11} = 1.76 \text{ weeks}$$



chance that the entire project will be completed in less than the expected 15 weeks and a 50% chance that it will exceed 15 weeks.[2]

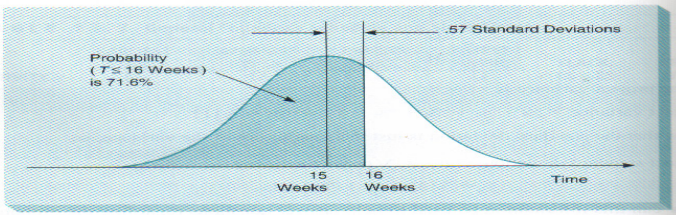
For Harky to find the probability that his project will be finished on or before the 16-week deadline, he needs to determine the appropriate area under the normal curve. The standard normal equation can be applied as follows:

$$Z = \frac{\text{due date} - \text{expected date of completion}}{\sigma_T}$$
$$= \frac{16 \text{ weeks} - 15 \text{ weeks}}{1.76 \text{ weeks}} = 0.57 \qquad (13\text{-}7)$$

where

Z is the number of standard deviations the due date or target date lies from the mean or expected date.

Referring to the normal table in Appendix A, we find a probability of 0.71566. Thus, there is a 71.6% chance that the pollution control equipment can be put in place in 16 weeks or less. This is shown in Figure 13.8.



g. Tabel Z

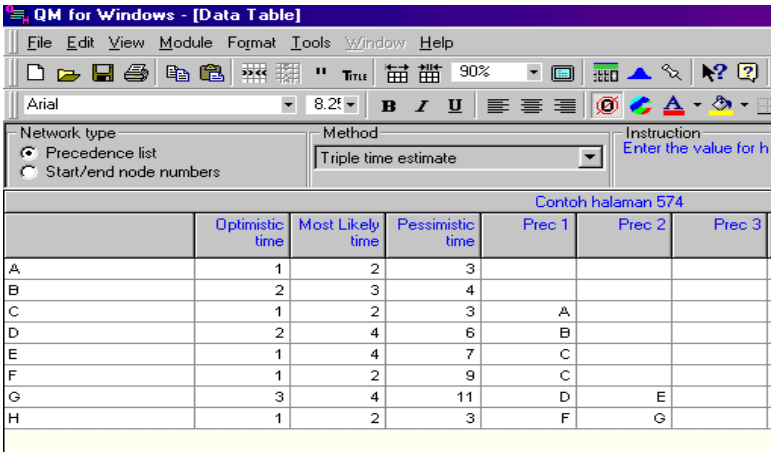
APPENDIX A: AREAS UNDER THE STANDARD NORMAL CURVE

Example: To find the area under the normal curve, you must know how many standard deviations that point is to the right of the mean. Then the area under the normal curve can be read directly from the normal table. For example, the total area under the normal curve for a point that is 1.55 standard deviations to the right of the mean is .93943.

	00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73536	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97784	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520

h. Contoh Pert dengan QM for windows

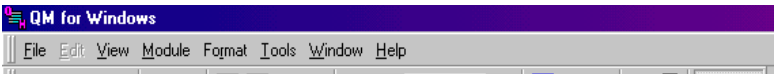
i. Cara memasukan data – lihat halaman 574



Contoh halaman 574

	Optimistic time	Most Likely time	Pessimistic time	Prec 1	Prec 2	Prec 3
A	1	2	3			
B	2	3	4			
C	1	2	3	A		
D	2	4	6	B		
E	1	4	7	C		
F	1	2	9	C		
G	3	4	11	D	E	
H	1	2	3	F	G	

ii. Hasil

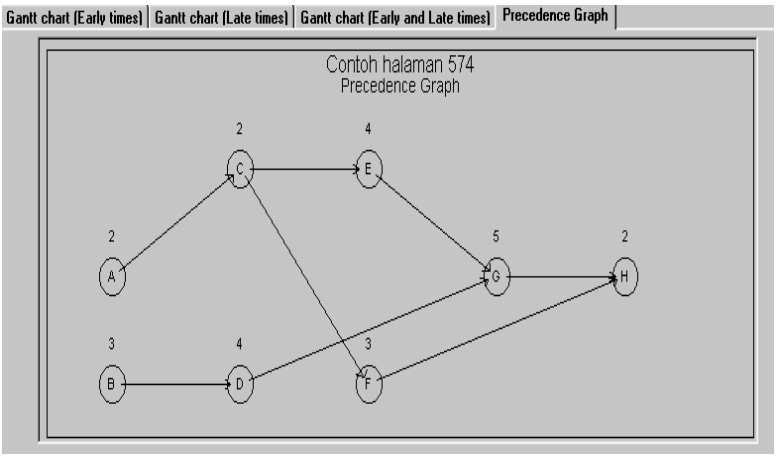


Project Management (PERT/CPM) Results

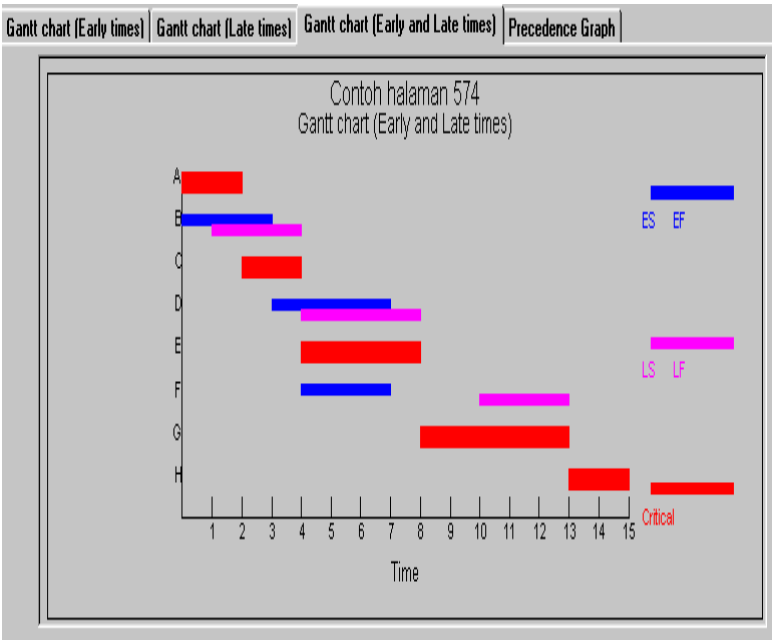
Contoh halaman 574 Solution

	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation
Project	15,						1,7638
A	2,	0,	2,	0,	2,	0,	0,3333
B	3,	0,	3,	1,	4,	1,	0,3333
C	2,	2,	4,	2,	4,	0,	0,3333
D	4,	3,	7,	4,	8,	1,	0,6667
E	4,	4,	8,	4,	8,	0,	1,
F	3,	4,	7,	10,	13,	6,	1,3333
G	5,	8,	13,	8,	13,	0,	1,3333
H	2,	13,	15,	13,	15,	0,	0,3333

iii. Gambar PERT



iv. Gambar Gantt – Chart



Bab 10 WAITING LINES & QUEUING THEORY

p567-2006

Teori antrian adalah antrian / barisan yang sedang menunggu untuk dilayani merupakan metode kuantitatif yang tertua dan paling banyak digunakan.

Pertanyaan yang muncul pada model ini adalah : ‘ ideal level of services that a firm should provide’.

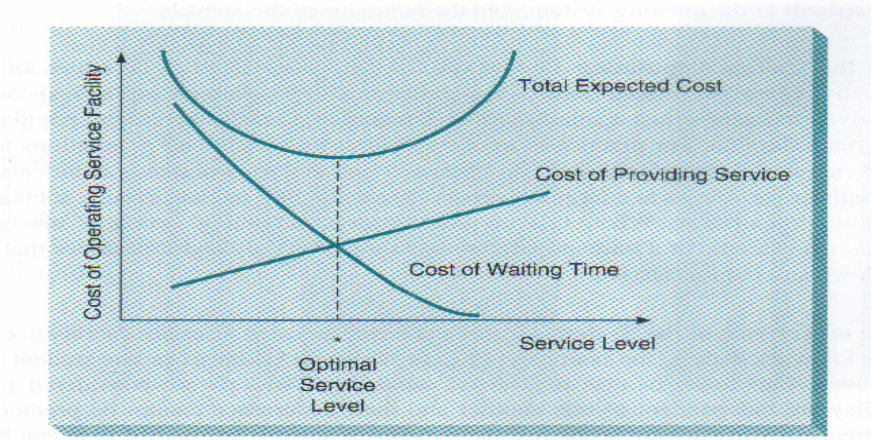
Contoh :

- Supermarket ---→ berapa kas register yang diperlukan pada saat check-out,
- Gasoline station → berapa pompa yang harus disediakan
- Bank → berapa extra teller agar pelayanan menjadi lebih baik ?

Berarti ada trade-off antara :

- ✓ Good service → high cost. Dengan
- ✓ Low cost → high waiting time (dissatisfaction)

Lihat gambar berikut ini :



Untuk menyelesaikan persoalan antrian ini digunakan beberapa asumsi a.l. :

- ✓ Karakteristik kedatangan (λ =lamdha) mengikuti pola kedatangan random yng dsikenal dengan ***'Poisson distribution'*** dengan formula sbb :

$$P(X) = \frac{e^{-\lambda}\lambda^{X}}{X!} \quad \text{for } X = 0, 1, 2, 3, 4, \ldots$$

where

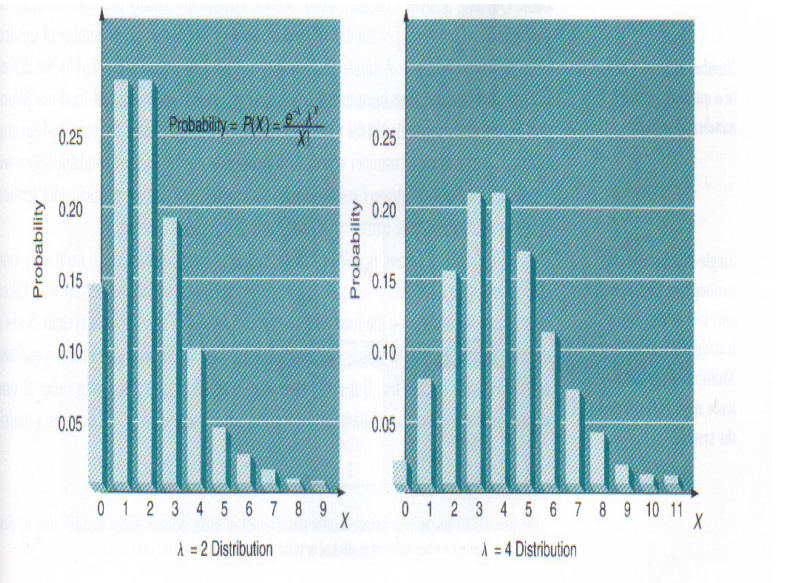
$P(X)$ = probability of X arrivals

X = number of arrivals per unit of time

λ = average arrival rate

e = 2.7183

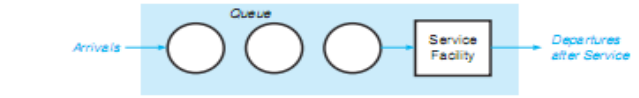
Kalau misalkan $\lambda = 2$ dan $\lambda = 4$ maka terlihat pola distribusinya sbb :



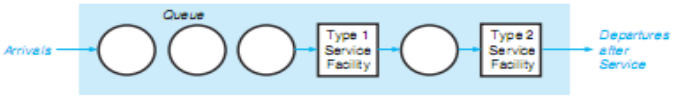
✓ Asumsi lainnya sbb :

Tergantung pada model antrain yang terjadi dan banyaknya sistim pelayanan yang ada.

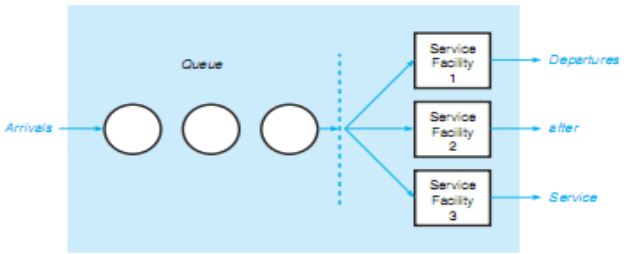
Terdapat 4 bentuk sistim antrian sbb :



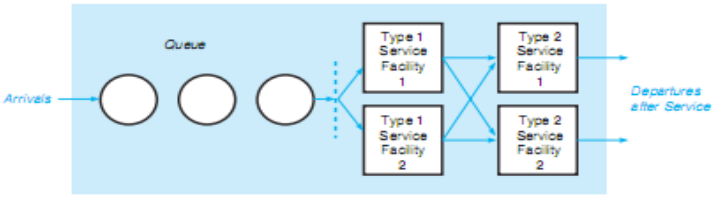
Single-Channel, Single-Phase System



Single-Channel, Multiphase System

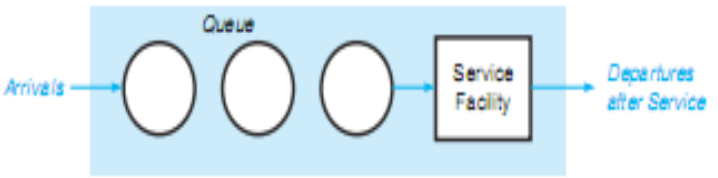


Multichannel, Single-Phase System



Multichannel, Multiphase System

Untuk contoh kita saat ini digunakan model sbb :



Single-Channel, Single-Phase System

Dengan asumsi sbb :

Assumptions of the Model

The single-channel, single-phase model considered here is one of the most widely used and simplest queuing models. It involves assuming that seven conditions exist:

1. Arrivals are served on a FIFO basis.
2. Every arrival waits to be served regardless of the length of the line; that is, there is no balking or reneging.
3. Arrivals are independent of preceding arrivals, but the average number of arrivals (the arrival rate) does not change over time.
4. Arrivals are described by a Poisson probability distribution and come from an infinite or very large population.
5. Service times also vary from one customer to the next and are independent of one another, but their average rate is known.
6. Service times occur according to the negative exponential probability distribution.
7. The average service rate is greater than the average arrival rate.

When these seven conditions are met, we can develop a series of equations that define the queue's **operating characteristics**. The mathematics used to derive each equation is rather complex and outside the scope of this book, so we will just present the resulting formulas here.

Formula waiting lines sbb :

λ = mean number of arrivals per time period (for example, per hour)
μ = mean number of people or items served per time period

The average number of customers in the queue, L_q:

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

The average time a customer spends waiting in the queue, W_q:

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$$

The **utilization factor** for the system, ρ (the Greek lowercase letter rho), that is, the probability that the service facility is being used:

$$\rho = \frac{\lambda}{\mu}$$

The percent idle time, P_0, that is, the probability that no one is in the system:

$$P_0 = 1 - \frac{\lambda}{\mu}$$

The probability that the number of customers in the system is greater than k, $P_{n>k}$:

$$P_{n>k} = \left(\frac{\lambda}{\mu}\right)^{k+1}$$

(lihat juga p506-7, Render, Stair, and Hanna, 2012)

Arnold's Muffler Shop Case

We now apply these formulas to the case of Arnold's Muffler Shop in New Orleans. Arnold's mechanic, Reid Blank, is able to install new mufflers at an average rate of 3 per hour, or about 1 every 20 minutes. Customers needing this service arrive at the shop on the average of 2 per hour. Larry Arnold, the shop owner, studied queuing models in an MBA program and feels that all seven of the conditions for a single-channel model are met. He proceeds to calculate the numerical values of the preceding operating characteristics:

λ = 2 cars arriving per hour

μ = 3 cars serviced per hour

$$L = \frac{\lambda}{\mu - \lambda} = \frac{2}{3-2} = \frac{2}{1} = 2 \text{ cars in the system on the average}$$

$$W = \frac{1}{\mu - \lambda} = \frac{1}{3-2} = 1 \text{ hour that an average car spends in the system}$$

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{2^2}{3(3-2)} = \frac{4}{3(1)} = \frac{4}{3} = 1.33 \text{ cars waiting in line on the average}$$

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{2}{3(3-2)} = \frac{2}{3} \text{ hour} = 40 \text{ minutes} = \text{average waiting time per car}$$

Note that W and W_q are in *hours*, since λ was defined as the number of arrivals per *hour*.

$$\rho = \frac{\lambda}{\mu} = \frac{2}{3} = 0.67 = \text{percentage of time mechanic is busy, or the probability that the server is busy}$$

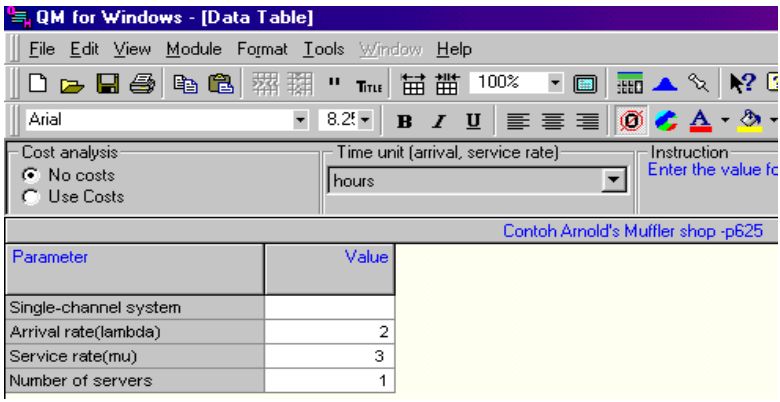
$$P_0 = 1 - \frac{\lambda}{\mu} = 1 - \frac{2}{3} = 0.33 = \text{probability that there are 0 cars in the system}$$

(p507,2012)

Probability of More than k Cars in the System

k	$P_{n>k} = \left(\frac{2}{3}\right)^{k+1}$	
0	0.667	← *Note that this is equal to* $1 - P_0 = 1 - 0.33 = 0.667$.
1	0.444	
2	0.296	
3	0.198	← *Implies that there is a 19.8% chance that more than 3 cars are in the system.*
4	0.132	
5	0.088	
6	0.058	
7	0.039	

Contoh dengan paket – komputer QM :



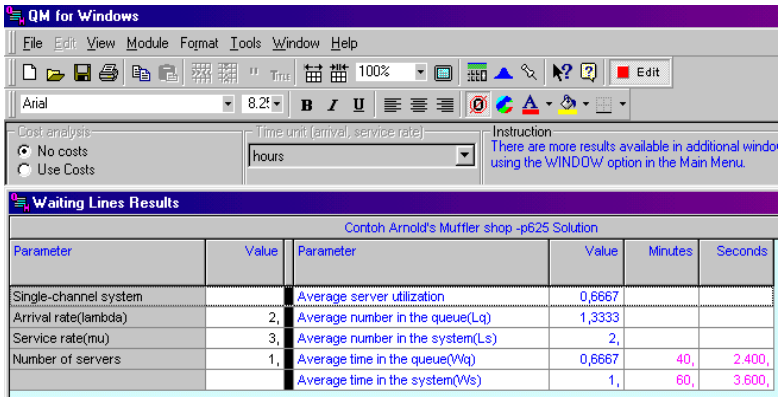
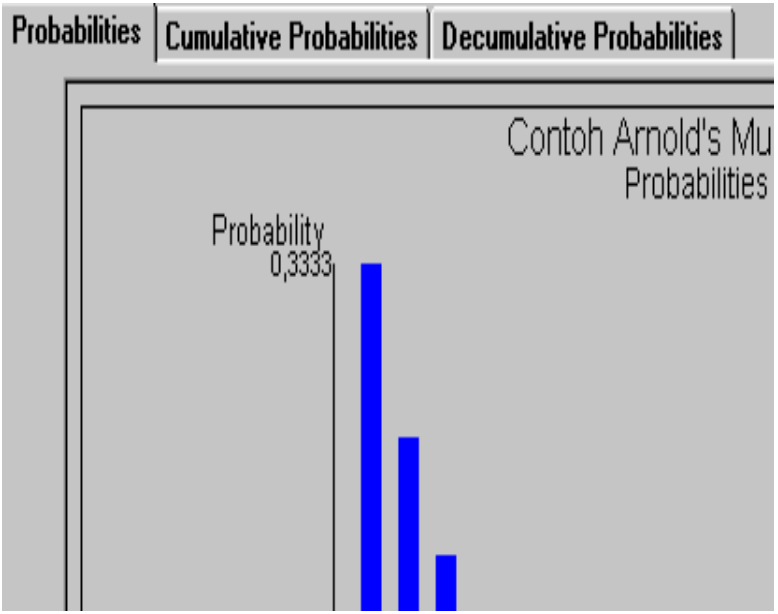


Table of Probabilities

Contoh Arnold's Muffler shop -p625 Solution

k	Prob (num in sys = k)	Prob (num in sys <= k)	Prob (num in sys >k)
0	0,3333	0,3333	0,6667
1	0,2222	0,5556	0,4444
2	0,1481	0,7037	0,2963
3	0,0988	0,8025	0,1975
4	0,0658	0,8683	0,1317
5	0,0439	0,9122	0,0878
6	0,0293	0,9415	0,0585
7	0,0195	0,961	0,039
8	0,013	0,974	0,026
9	0,0087	0,9827	0,0173
10	0,0058	0,9884	0,0116
11	0,0039	0,9923	0,0077



Formula lainnya untuk :

- ✓ Multichannel sbb :

Equations for the Multichannel Queuing Model

If we let

m = number of channels open,
λ = average arrival rate, and
μ = average service rate at each channel

the following formulas may be used in the waiting line analysis:

1. The probability that there are zero customers or units in the system:

$$P_0 = \frac{1}{\left[\sum_{n=0}^{n=m-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n\right] + \frac{1}{m!}\left(\frac{\lambda}{\mu}\right)^m \frac{m\mu}{m\mu - \lambda}} \quad \text{for } m\mu > \lambda$$

2. The average number of customers or units in the system:

$$L = \frac{\lambda\mu(\lambda/\mu)^m}{(m-1)!(m\mu - \lambda)^2}P_0 + \frac{\lambda}{\mu}$$

3. The average time a unit spends in the waiting line or being serviced (namely, in the system):

$$W = \frac{\mu(\lambda/\mu)^m}{(m-1)!(m\mu - \lambda)^2}P_0 + \frac{1}{\mu} = \frac{L}{\lambda}$$

4. The average number of customers or units in line waiting for service:

$$L_q = L - \frac{\lambda}{\mu}$$

5. The average time a customer or unit spends in the queue waiting for service:

$$W_q = W - \frac{1}{\mu} = \frac{L_q}{\lambda}$$

6. Utilization rate:

$$\rho = \frac{\lambda}{m\mu}$$

(p512, 2012)

✓ ***Model Constant service :***

Equations for the Constant Service Time Model

Constant service model formulas follow:

1. Average length of the queue:

$$L_q = \frac{\lambda^2}{2\mu(\mu - \lambda)}$$

2. Average waiting time in the queue:

$$W_q = \frac{\lambda}{2\mu(\mu - \lambda)}$$

3. Average number of customers in the system:

$$L = L_q + \frac{\lambda}{\mu}$$

4. Average time in the system:

$$W = W_q + \frac{1}{\mu}$$

(p519,2012)

✓ ***Finite Popuation Model :***

λ = mean arrival rate, μ = mean service rate, N = size of the population

1. Probability that the system is empty:

$$P_0 = \frac{1}{\sum_{n=0}^{N} \frac{N!}{(N-n)!}\left(\frac{\lambda}{\mu}\right)^n}$$

2. Average length of the queue:

$$L_q = N - \left(\frac{\lambda + \mu}{\lambda}\right)(1 - P_0)$$

3. Average number of customers (units) in the system:

$$L = L_q + (1 - P_0)$$

4. Average waiting time in the queue:

$$W_q = \frac{L_q}{(N - L)\lambda}$$

5. Average time in the system:

$$W = W_q + \frac{1}{\mu}$$

6. Probability of n units in the system:

$$P_n = \frac{N!}{(N-n)!}\left(\frac{\lambda}{\mu}\right)^n P_0 \quad \text{for } n = 0, 1, \ldots, N$$

(p517,2012)

Department of Commerce Example

Past records indicate that each of the five high-speed "page" printers at the U.S. Department of Commerce, in Washington, D.C., needs repair after about 20 hours of use. Breakdowns have been determined to be Poisson distributed. The one technician on duty can service a printer in an average of 2 hours, following an exponential distribution.

To compute the system's operation characteristics we first note that the mean arrival rate is $\lambda = 1/20 = 0.05$ printer/hour. The mean service rate is $\mu = 1/2 = 0.50$ printer/hour. Then

1. $P_0 = \dfrac{1}{\sum_{n=0}^{5} \frac{5!}{(5-n)!}\left(\frac{0.05}{0.5}\right)^n} = 0.564$ (we leave these calculations for you to confirm)

2. $L_q = 5 - \left(\dfrac{0.05 + 0.5}{0.05}\right)(1 - P_0) = 5 - (11)(1 - 0.564) = 5 - 4.8$
   $= 0.2$ printer

3. $L = 0.2 + (1 - 0.564) = 0.64$ printer

4. $W_q = \dfrac{0.2}{(5 - 0.64)(0.05)} = \dfrac{0.2}{0.22} = 0.91$ hour

5. $W = 0.91 + \dfrac{1}{0.50} = 2.91$ hours

If printer downtime costs \$120 per hour and the technician is paid \$25 per hour, we can also compute the total cost per hour:

Total hourly cost = (Average number of printers down)(Cost per downtime hour)
+ Cost per technician hour
= (0.64)(\$120) + \$25 = \$76.80 + \$25.00 = \$101.80

Bab 11 GOAL PROGRAMMING

p469-2006

Misalkan sebuah perusahaan Listrik Harrison (lihat integer programing p474-2003) membuat 2 (dua) macam product yaitu :

X1 = old fashion chaneliers
X2 = ceiling fans

Untuk membuat kedua macam product tersebut data / informasi yang dimiliki sbb :

	X1	X2	
Max profit	$ 7	$ 6	
Stc	2	3	$\leq$ 12 **(wiring hour)**
	6	5	$\leq$ 30 **(assembly hours)**

Untuk membuat kedua product diatas ada sasaran (goal) lain yang diinginkan oleh management yaitu :

1. **Profit level yang dinginkan minimum $ 30 – Goal pertama :**

   Untuk memformulasikan keinginan diatas maka dibutuhkan notasi baru yaitu :

   Notasi d_1^- = underachievement profit target
   Dan d_1^+ = overachievement profit target

Sehingga FUNGSI PROFIT MENJADI KENDALA BARU yaitu $\$7\,x1 + \$6\,x2 + d_1^- - d_1^+ = \$30$ *(Goal Profit)*

Fungsi sasaran menjadi Min = d^-_1 (yaitu me-minimkan target profit paling sedikit $30, dan kalau profit ini meadi prioritas / goal pertama (utama) maka diberik notasi pada **fungsi sasaran yang baru** menjadi $Min = P_1 d_1^-$

2. Sasaran berikutnya adalah 'fully utilize' seluruh 'wiring hours', atau tidak menginginkan adanya 'under-utilize' dari department ini atau menghindari pengangguran (idle time) pada departemen wiring – goal ini sebagai perioritas nomor 2 yang berarti ***minimize*** d_2^- yang berarti fungsi sasaran diperbaiki menjadi $Min = P_1 d_1^- + P_2 d_2^-$

   Dan fungsi kendala dari departemen wiring dirubah menjadi :

   $$2x1 + 3\,x2 + d_2^- - d_2^+ = 12$$

3. Sebagai prioritas ketiga / goal ketiga yaitu perlunya menghindari 'overtime' dari departement assembly yang berarti meminimkan d_3^+ sehingga fungsi objective berubah menjadi :
   $Min = P_1 d_1^- + P_2 d_2^- + P_3 d_3^+$, ***dan kendala*** baru adalah
   $6x1 + 5x2 + d_3^- - d_3^+ = 30$

4. Prioritas keempat diinginkan agas memproduksi paling sedikit ceiling fans = 7 buah (berarti tidak boleh diproduksi kurang dari 7 atau menghindari under productive) dengan demikian fungsi sasaran menjadi bertambah lagi menjadi :

$$Min = P_1 d_1^- + P_2 d_2^- + P_3 d_3^+ + P_4 d_4^-$$

Dan fungsi kendala akan bertambah sebagai berikut :

$$X_2 + d_4^- - d_4^+ = 7$$

5. Dari hasil modifikasi diatas maka model liner programming yang telah memasukkan 4 (empat) sasaran baru (disebut Goal programming) menjadi sebagai berikut :

$$Min = P_1 d_1^- + P_2 d_2^- + P_3 d_3^+ + P_4 d_4^-$$

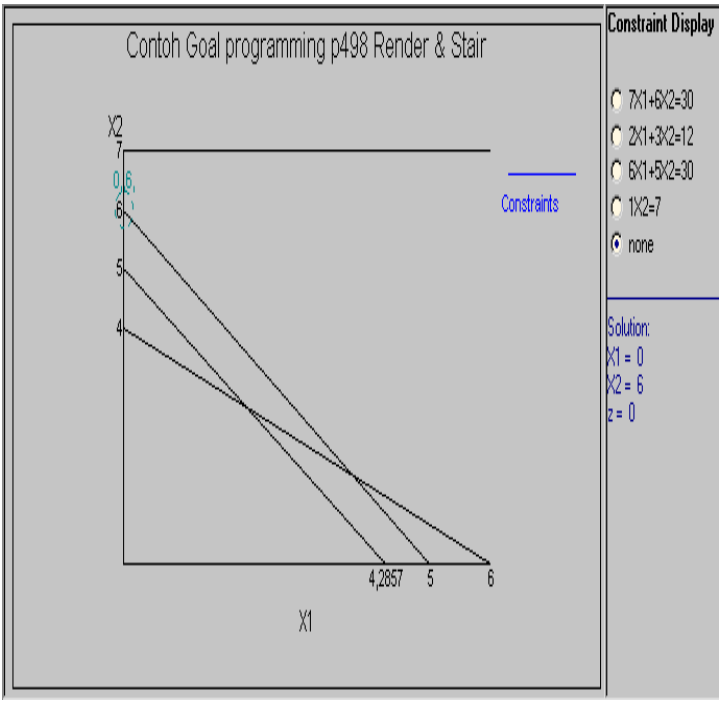
$$STC : \quad \$7\,x1 + \$6\,x2 + d_1^- - d_1^+ = \$30 \text{ (profit)}$$

$$2x1 + 3\,x2 + d_2^- - d_2^+ = 12 \text{ (wiring)}$$

$$6x1 + 5x2 + d_3^- - d_3^+ = 30 \text{ (assembly)}$$

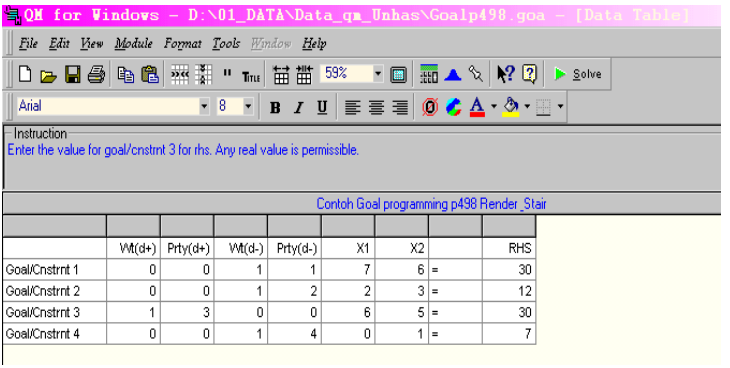
$$x_2 + d_4^- - d_4^+ = 7 \text{ (fans)}$$

6. Untuk menyelesaikan problema ini digunakan cara :
   - Cara Grafis karena hanya dimensi (product)



- Cara simplex tableau

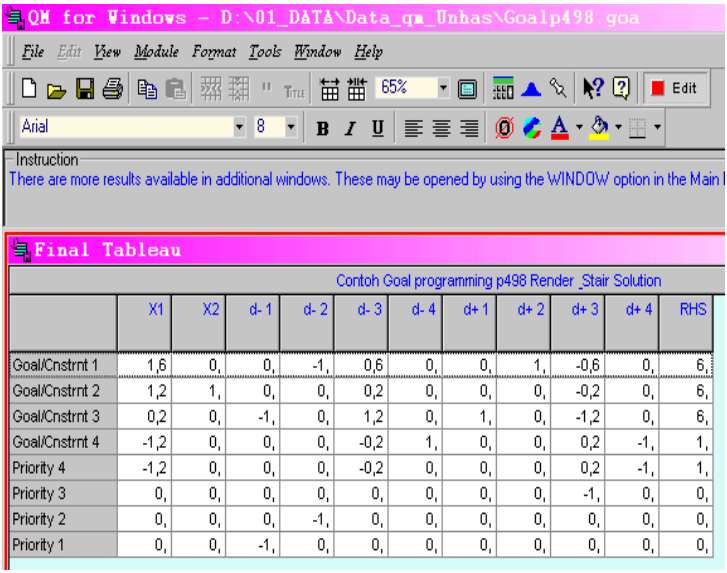
  Masukkan data sbb :



	Wt(d+)	Prty(d+)	Wt(d-)	Prty(d-)	X1	X2		RHS
Goal/Cnstrnt 1	0	0	1	1	7	6	=	30
Goal/Cnstrnt 2	0	0	1	2	2	3	=	12
Goal/Cnstrnt 3	1	3	0	0	6	5	=	30
Goal/Cnstrnt 4	0	0	1	4	0	1	=	7

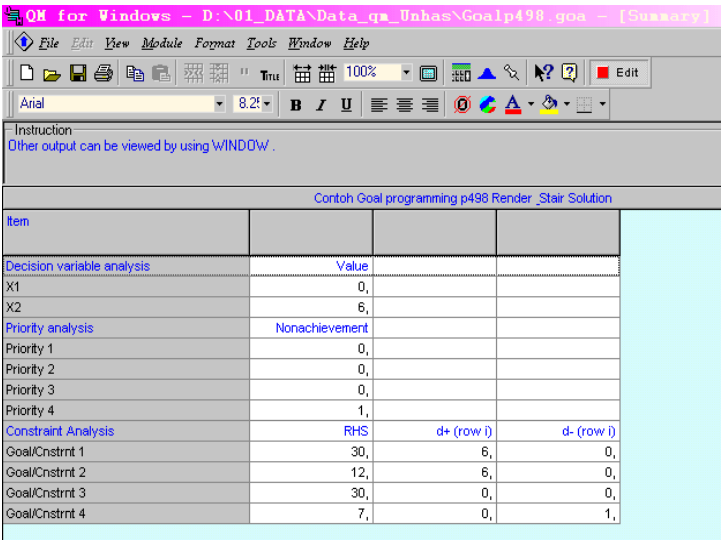
Problem diselesaikan (SOLVE) sbb :

Final Table sbb :



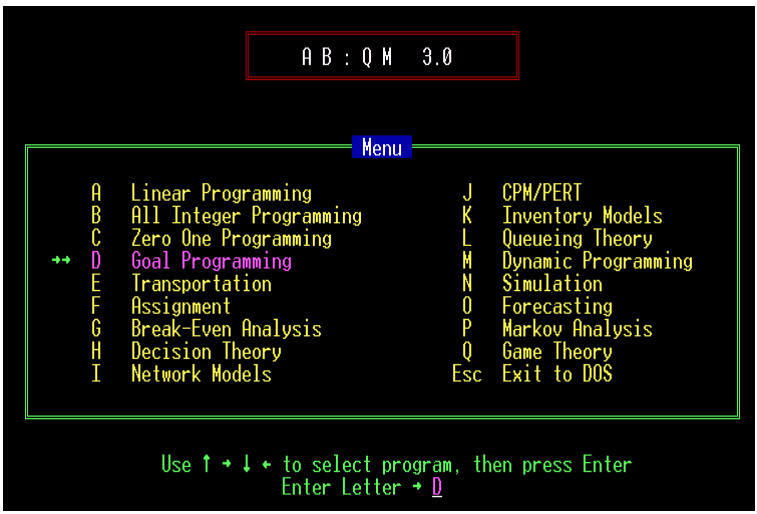
	X1	X2	d- 1	d- 2	d- 3	d- 4	d+ 1	d+ 2	d+ 3	d+ 4	RHS
Goal/Cnstrnt 1	1,6	0,	0,	-1,	0,6	0,	0,	1,	-0,6	0,	6,
Goal/Cnstrnt 2	1,2	1,	0,	0,	0,2	0,	0,	0,	-0,2	0,	6,
Goal/Cnstrnt 3	0,2	0,	-1,	0,	1,2	0,	1,	0,	-1,2	0,	6,
Goal/Cnstrnt 4	-1,2	0,	0,	0,	-0,2	1,	0,	0,	0,2	-1,	1,
Priority 4	-1,2	0,	0,	0,	-0,2	0,	0,	0,	0,2	-1,	1,
Priority 3	0,	0,	0,	0,	0,	0,	0,	0,	-1,	0,	0,
Priority 2	0,	0,	0,	-1,	0,	0,	0,	0,	0,	0,	0,
Priority 1	0,	0,	-1,	0,	0,	0,	0,	0,	0,	0,	0,

Hasil ringkas sbb :

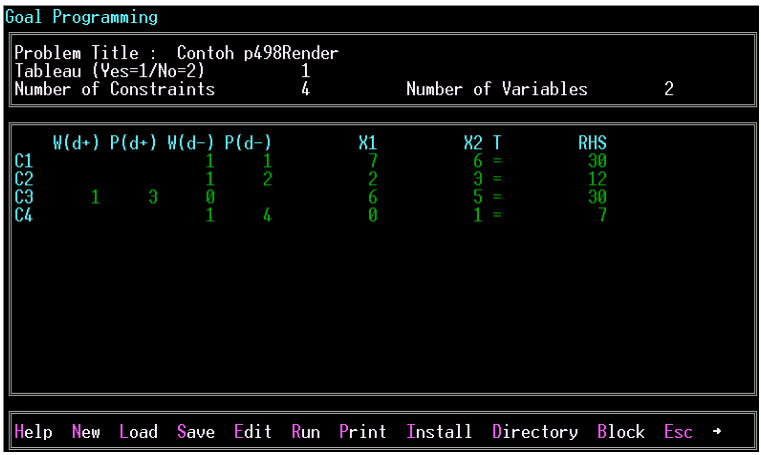


Item			
Decision variable analysis	Value		
X1	0,		
X2	6,		
Priority analysis	Nonachievement		
Priority 1	0,		
Priority 2	0,		
Priority 3	0,		
Priority 4	1,		
Constraint Analysis	RHS	d+ (row i)	d- (row i)
Goal/Cnstrnt 1	30,	6,	0,
Goal/Cnstrnt 2	12,	6,	0,
Goal/Cnstrnt 3	30,	0,	0,
Goal/Cnstrnt 4	7,	0,	1,

7. Jika menggunakan paket QM for DOS akan dapat dilihat tabel tabel simplex seperti pada text-book. Cara untuk mengerjakan paket ini sbb :



Masukkan data sbb :



Run dan hasilnya sbb :

Initial Tableau

\Cj Cb\	Basis	Bi	0 x1	0 x2	1P1 d-1	1P2 d-2
1P1	d-1	30.000	7.000	6.000	1.000	0.000
1P2	d-2	12.000	2.000	3.000	0.000	1.000
0	d-3	30.000	6.000	5.000	0.000	0.000
1P4	d-4	7.000	0.000	1.000	0.000	0.000
Zj-Cj	1P4	7.000	0.000	1.000	0.000	0.000
	1P3	0.000	0.000	0.000	0.000	0.000
	1P2	12.000	2.000	3.000	0.000	0.000
	1P1	30.000	7.000	6.000	0.000	0.000

Subject to

C1 7x1 + 6x2 + d-1 - d+1 = 30
C2 2x1 + 3x2 + d-2 - d+2 = 12
C3 6x1 + 5x2 + d-3 - d+3 = 30
C4 1x2 + d-4 - d+4 = 7

\Cj Cb\	Basis	Bi	0 d-3	1P4 d-4	0 d+1	0 d+2
1P1	d-1	30.000	0.000	0.000	-1.000	0.000
1P2	d-2	12.000	0.000	0.000	0.000	-1.000
0	d-3	30.000	1.000	0.000	0.000	0.000
1P4	d-4	7.000	0.000	1.000	0.000	0.000
Zj-Cj	1P4	7.000	0.000	0.000	0.000	0.000
	1P3	0.000	0.000	0.000	0.000	0.000
	1P2	12.000	0.000	0.000	0.000	-1.000
	1P1	30.000	0.000	0.000	-1.000	0.000

\Cj / Cb\	Basis	Bi	1P3 d+3	0 d+4
1P1	d-1	30.000	0.000	0.000
1P2	d-2	12.000	0.000	0.000
0	d-3	30.000	-1.000	0.000
1P4	d-4	7.000	0.000	-1.000
Zj-Cj	1P4	7.000	0.000	-1.000
	1P3	0.000	-1.000	0.000
	1P2	12.000	0.000	0.000
	1P1	30.000	0.000	0.000

Final Solution Tableau at Iteration 7

\Cj / Cb\	Basis	Bi	0 x1	0 x2	1P1 d-1	1P2 d-2
0	d+2	6.000	1.600	0.000	0.000	-1.000
0	x2	6.000	1.200	1.000	0.000	0.000
0	d+1	6.000	0.200	0.000	-1.000	0.000
1P4	d-4	1.000	-1.200	0.000	0.000	0.000
Zj-Cj	1P4	1.000	-1.200	0.000	0.000	0.000
	1P3	0.000	0.000	0.000	0.000	0.000
	1P2	0.000	0.000	0.000	0.000	-1.000
	1P1	0.000	0.000	0.000	-1.000	0.000

\Cj / Cb\	Basis	Bi	0 d-3	1P4 d-4	0 d+1	0 d+2
0	d+2	6.000	0.600	0.000	0.000	1.000
0	x2	6.000	0.200	0.000	0.000	0.000
0	d+1	6.000	1.200	0.000	1.000	0.000
1P4	d-4	1.000	-0.200	1.000	0.000	0.000
Zj-Cj	1P4	1.000	-0.200	0.000	0.000	0.000
	1P3	0.000	0.000	0.000	0.000	0.000
	1P2	0.000	0.000	0.000	0.000	0.000
	1P1	0.000	0.000	0.000	0.000	0.000

\Cj Cb\	Basis	Bi	1P3 d+3	0 d+4
0	d+2	6.000	-0.600	0.000
0	x2	6.000	-0.200	0.000
0	d+1	6.000	-1.200	0.000
1P4	d-4	1.000	0.200	-1.000
Zj-Cj	1P4	1.000	0.200	-1.000
	1P3	0.000	-1.000	0.000
	1P2	0.000	0.000	0.000
	1P1	0.000	0.000	0.000

Analysis of deviations

Constraint	RHS Value	d+	d-
C1	30.000	6.000	0.000
C2	12.000	6.000	0.000
C3	30.000	0.000	0.000
C4	7.000	0.000	1.000

Analysis of decision variables

Variable	Solution Value
X1	0.000
X2	6.000

Analysis of the objective function

Priority	Nonachievement
P1	0.000
P2	0.000
P3	0.000
P4	1.000

***** End of Output *****

Kerjakan halaman 514 soal No. 11-29, dan 11-30 atau
P490-2006

Bab 12 NETWORK MODELS

P498-2006

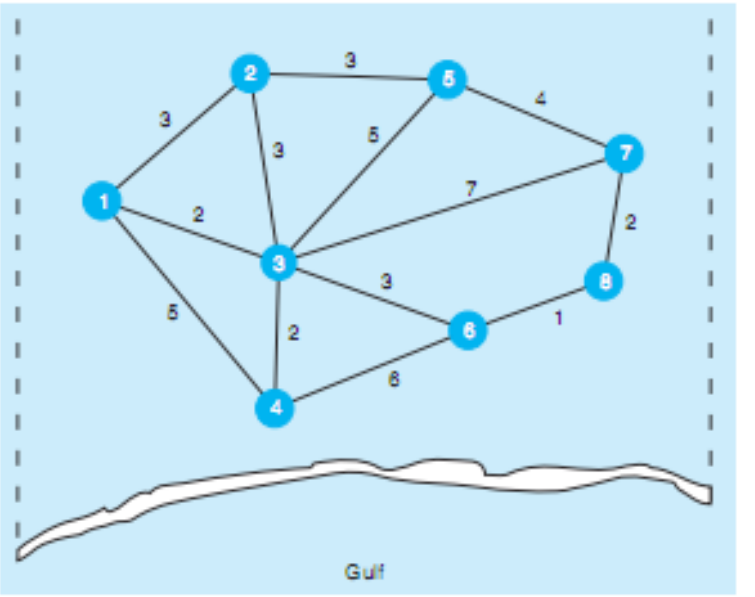
12.1. Bentuk Network Models.

Terdiri atas :
1. Minimal-Spinning tree technique
2. Maximum-flow technique
3. Shortest – route technique

12.2. Minimal-spinning tree technique

Minimal-spinning tree adalah suatu tehnik untuk menghubungkan seluruh titik/points dari suatu network dengan meminimkan 'distantance' diantara titik titik tersebut.

Contoh pada halaman 539 (Render & stair ed.7,2000) sbb : Misalkan Lauderdale construction Coy., mengembangkan perumahan mewah dan ingin memasukkan 'water & power' kemasing masing rumah dengan jarak antara rumah dalam 100 feets sbb :



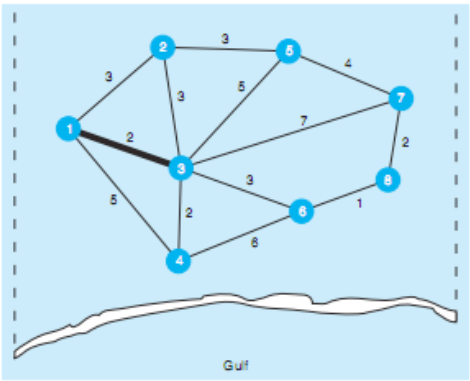
(lihat juga p431,2012)

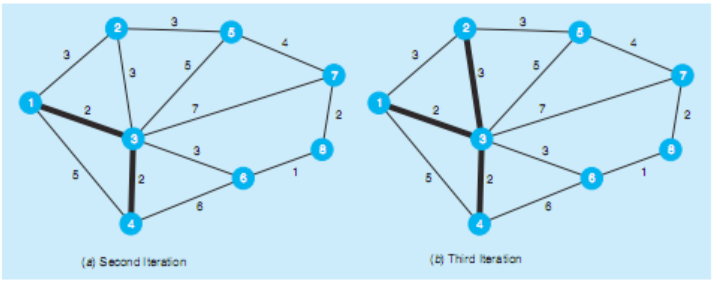
Untuk mengerjakan hal diatas dilakukan 5 steps yaitu sbb :

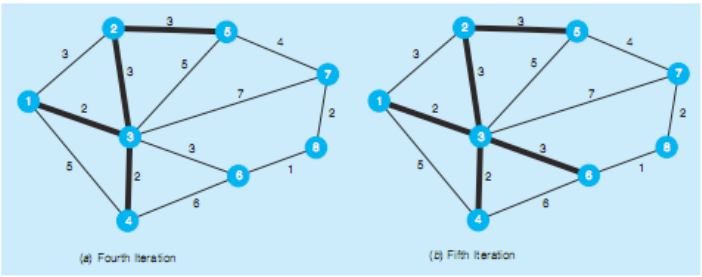
Steps for the Minimal-Spanning Tree Technique

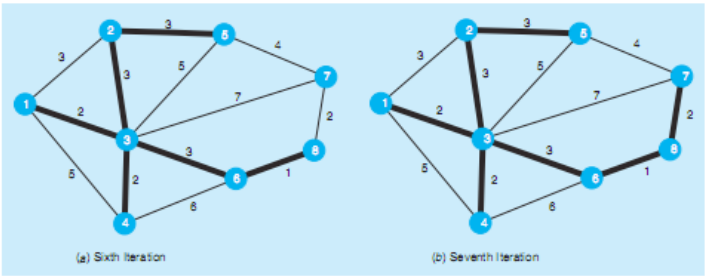
1. Select any node in the network.
2. Connect this node to the nearest node that minimizes the total distance.
3. Considering all of the nodes that are now connected, find and connect the nearest node that is not connected. If there is a tie for the nearest node, select one arbitrarily. A tie suggests there may be more than one optimal solution.
4. Repeat the third step until all nodes are connected.

Misalkan kita memulai dari titik no. 1, jarak yang paling minimal adalah 1→ 3 (yaitu 200 feet – kode 2)
Maka dilakukan koneksi sbb :


Gulf

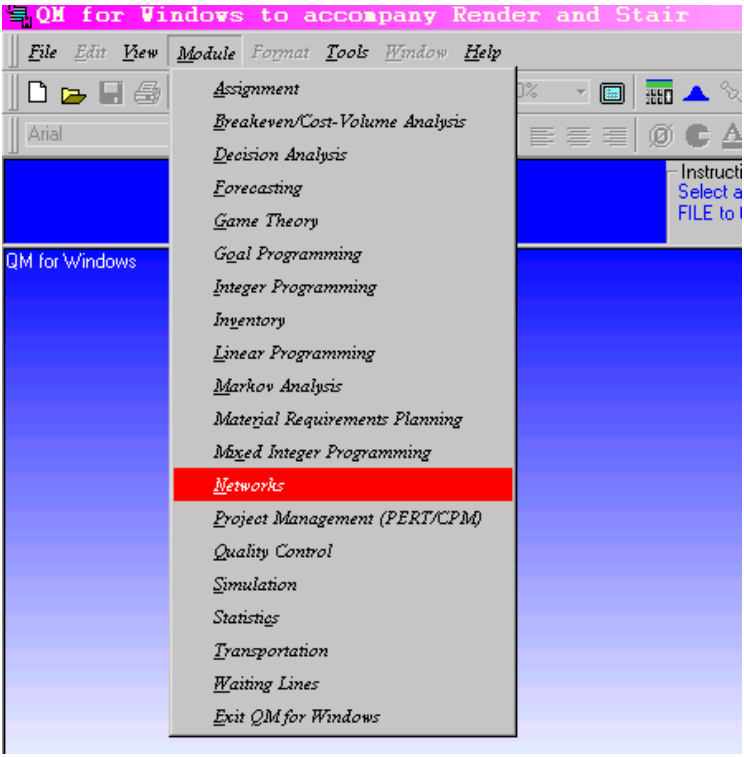

(a) Second Iteration
(b) Third Iteration

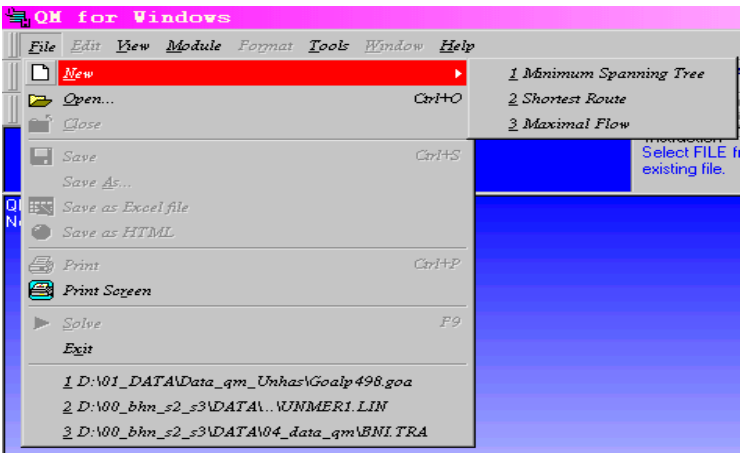

(a) Fourth Iteration
(b) Fifth Iteration


(a) Sixth Iteration
(b) Seventh Iteration

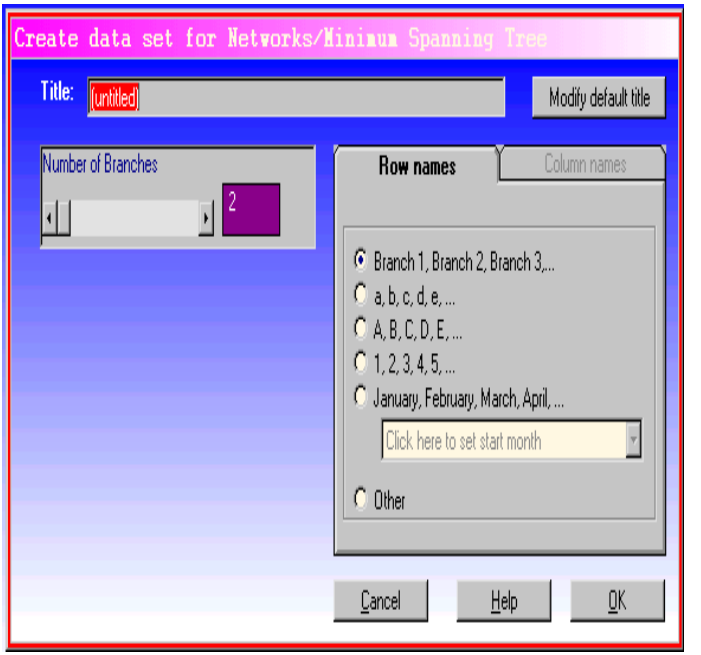
Jika dikerjakan dengan komputer hasilnya sbb :

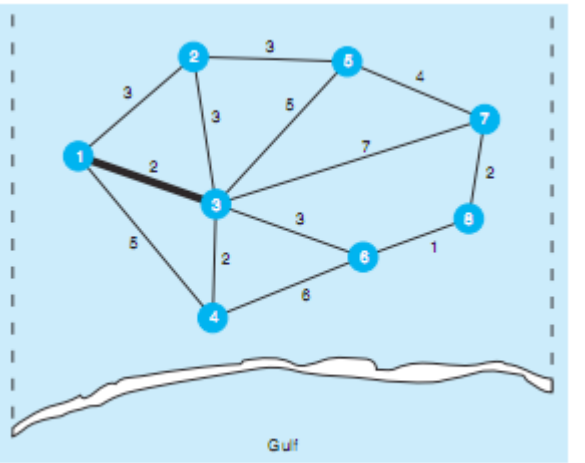
Step 1. panggil QM > Network>Minimal spin





Step 2. hitung jumlah branch yang ada pada gambar -jumlah 13





Step 3. Isikan dari – ke point dan biaya /
jaraknya sbb p522-2006 :

Contoh p539 - Komputer p565

Branch name	Start node	End node	Cost
1	1	2	3
2	1	3	2
3	1	4	5
4	2	3	3
5	2	5	3
6	3	4	2
7	3	5	5
8	3	6	3
9	3	7	7
10	4	6	6
11	5	7	4
12	6	8	1
13	7	8	2

Step 4. Hasilnya sebagai berikut :

QM for Windows - [Networks Results]

File Edit View Module Format Tools Window Help

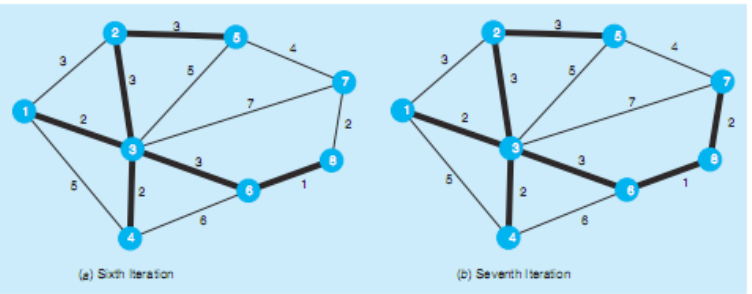
Arial 8.2 B I U

Starting node for iterations: 1

Note: Multiple optimal solutions exist

Contoh p539 - Komputer p565 solution

Branch name	Start node	End node	Cost	Include	Cost
1	1,	2,	3,	Y	3,
2	1,	3,	2,	Y	2,
3	1,	4,	5,		
4	2,	3,	3,		
5	2,	5,	3,	Y	3,
6	3,	4,	2,	Y	2,
7	3,	5,	5,		
8	3,	6,	3,	Y	3,
9	3,	7,	7,		
10	4,	6,	6,		
11	5,	7,	4,		
12	6,	8,	1,	Y	1,
13	7,	8,	2,	Y	2,
Total					16,



Bab 13 MARKOV DESICION ANALYSIS

Markovians Decision Process → Lihat Render et al., p645 2003 atau p653-2006 Chapter 16)

Misalkan penduduk 100,000 orang yang berbelanja pada departement store sbb :

	Departement store		
	American Food Store (AF) store #1	**Food mart (FM) store # 2**	**Atlas Foos (Atlas) Store # 3)**
Banyaknya orang yg berbelanja	**40,000 (π = 40% dari 100,000)**	**30000 (π 30%)**	**30000 (π 30%)**

Berarti probabilitas orang berbelanja **(π = probability)** pada keadaaan 1 **(state 1)** adalah **(0,4, 0.3, dan 0.3)**

Jika dilaksanakan penelitian kembali ternyata kondisinya **(matrix transition probabilities)** sbb :

	Departement #		
	# 1	#2	#3
Pembeli baru pada dept #1	**0.8**	0.1	0.1
Berasal dari dept #2	0.1	**0.7**	0.2
Berasal dari Dept #3	0.2	0.2	**0.6**
Total	100%	100%	100%

Pada tabel diatas terlihat bahwa mereka yang tetap berbelanja pada Dept #1 80% , dan mereka orang baru yang berasal dari depart #2 10% dan dari dept. #3 10% , demikian pula lainnya.

Jika ingin memprediksi **periode yang akan datang yaitu π (i)** dimana i = 1,2,3,4,5,6 …….. dstnya.

Maka untuk periode ke 1 yaitu $\pi (1) = \pi (0) * P$
dimana P = transition matrix

$$\pi (n+1) = \pi (n)\, P \text{ atau}$$
$$\pi (n) = \pi (0) P^n$$

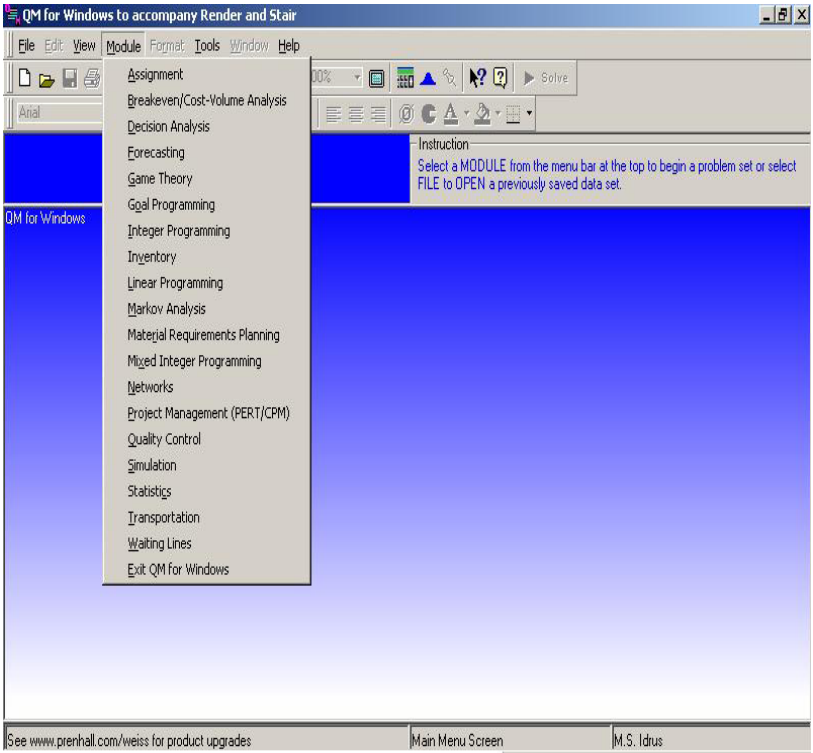
Untuk $\pi (1) = \pi (0) * P$ sbb :

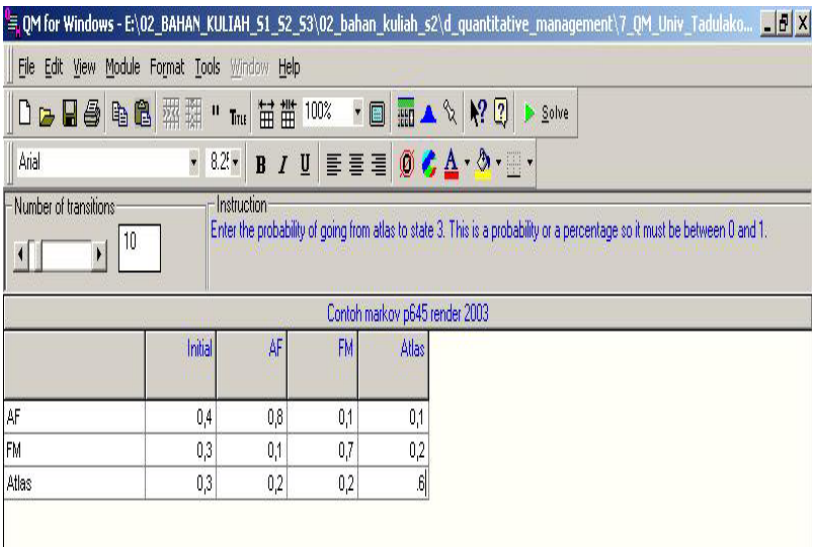
(0.4, 0.3, 0.3)	0.8	0.1	0.1
	0.1	**0.7**	0.2
	0.2	0.2	**0.6**

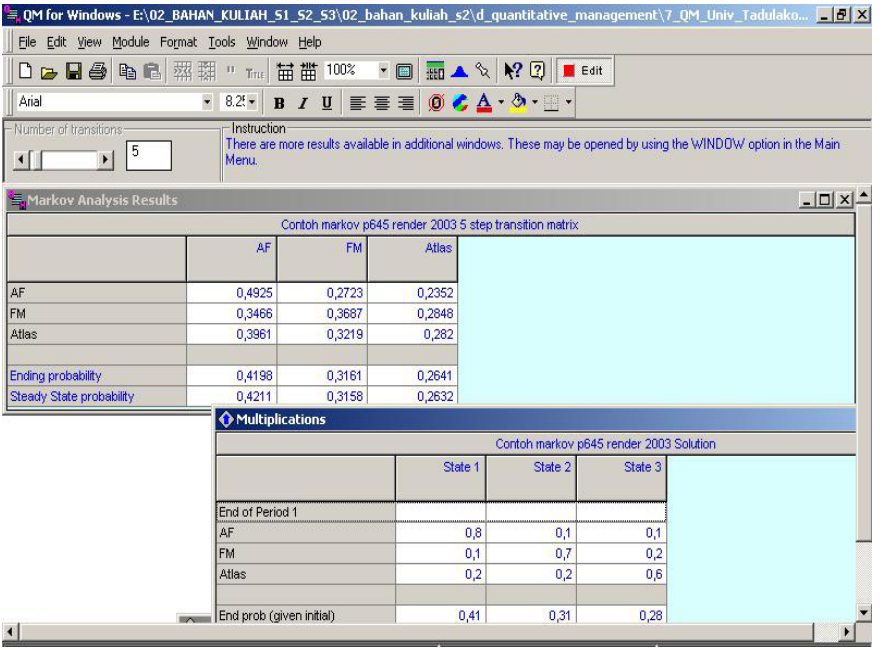
Perkalian matrix ini menghasilkan :

Untuk perode ke 1 orang yang berbelanja pada departement #1 adalah **0.4*0.8 + 0.3*0.1 + 0.3*0.2 = 0.32 + 0.03 + 0.06 = 0.41,** untuk dept. #2 adalah 0.31 dan Deprt # 3 = 0.28 (cobalah hitung sendiri) !!!!!!

Dengan menggunakan kompter QM akan terllihat sbb :






QM for Windows - E:\02_BAHAN_KULIAH_S1_S2_S3\02_bahan_kuliah_s2\d_quantitative_management\7_QM_Univ_Tadulako...
File Edit View Module Format Tools Window Help
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Arial
Number of transitions
5
Instruction
There are more results available in additional windows. These may be opened by using the WINDOW option in the Main Menu.
Markov Analysis Results
Contoh markov p645 render 2003 5 step transition matrix
AF FM Atlas
AF 0,4925 0,2723 0,2352
FM 0,3466 0,3687 0,2848
Atlas 0,3961 0,3219 0,282
Ending probability 0,4198 0,3161 0,2641
Steady State probability 0,4211 0,3158 0,2632
Multiplications
Contoh markov p645 render 2003 Solution
State 1 State 2 State 3
End of Period 1
AF 0,8 0,1 0,1
FM 0,1 0,7 0,2
Atlas 0,2 0,2 0,6
End prob (given initial) 0,41 0,31 0,28

Bab 14 GAMES THEORY

(p21-2003 atau lihat lihat - Module 4)

Misalkan ada dua orang pemain (X dan Y) menggunakan strategi promosi pemasaran menggunakan radio dan newspaper dengan prediksi hasil yang diperoleh dalam **ribuan $** , dengan **zero – sum games** yaitu jika salah seorang menang maka yang lain kalah jumlah kemenangan dan kekalahan adalah ZERO.

		Player Y dengan strategy (MINIMAX)	
		Radio	**Newspaper**
Player X dengan strategies sbb : (MAXIMIN)	**Radio**	**3**	**5**
	Newspaper	**1**	**-2**

MINIMAX = Minimizes **maximum loss** (Y strategy)
MAXIMIN = Maximizes **minimum gain** (X strategy)

		Payer Y dengan strategy (MINIMAX)		
Player X dengan strategies sbb : (MAXIMIN)		**Radio**	Newspaper	**X**- MIN Gain (keuntungan)
	Radio	**3**	5	3 maximin
	Newspaper	1	-2	(-2)
	Y- maximum LOSS (kalah)- minimax	(3)min	5	

X dengan strategy radio dan **Y dengan strategy Radio (saddle point)**, maka X memperoleh gain 3 dan Y loss 3 (Zero sum) atau saddle point (eiquilibrium) atau disebut juga PURE Strategy.

Mixed strategy terjadi apabila terjadi **NO SADDLE Point**.

Contoh sbb

		Player Y strategy		
		Y1	Y2	X Min Gain
Strategy Player X	X1	4	2	2 (Maximin)
	X2	1	10	1
	Y Max loss	4 (minimum loss)	10	

Untuk mejawab hal ini maka disusun persamaan baru sbb :

		Player Y strategy		
		Y1 (P)	Y2 (1-P)	Y expxted gain
Strategy Player X	X1 (Q)	**4**	2	**4P + 2 (1-P)**
	X2 (1-Q)	1	10	**1P+10(1-P)**
	X expected gain	**4Q+1(1-Q)**	**2Q+10Q(1-Q)**	

Strategy Y tidak bergantung pada strategy X menghasilkan :

4P+2(1-P) = 1P + 10(1-P)
2 + 2P = 10 – 9P
11 P = 8

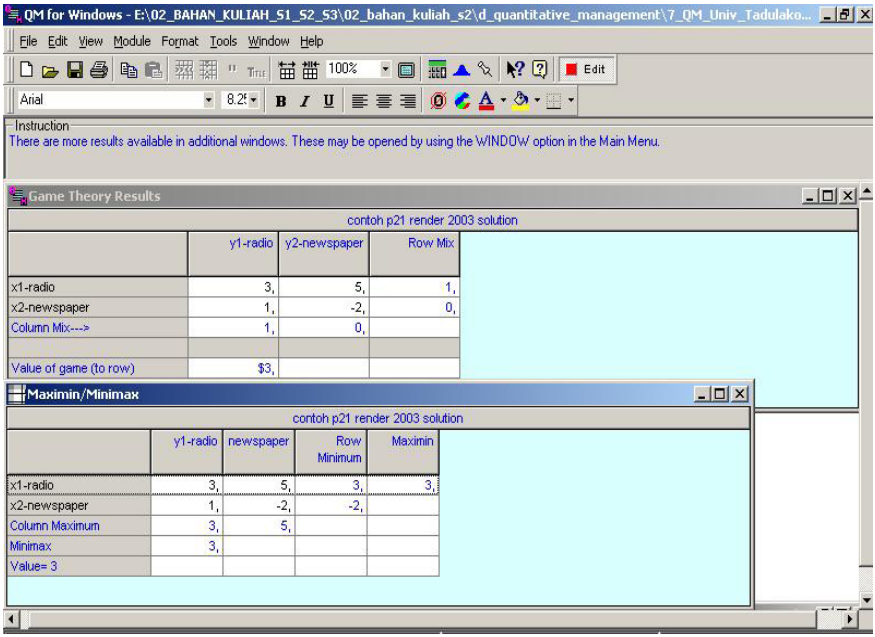
P $= \frac{8}{1}$ **dan** **1- P** $= \frac{3}{1}$ **hasil yang diperoleh adalah**

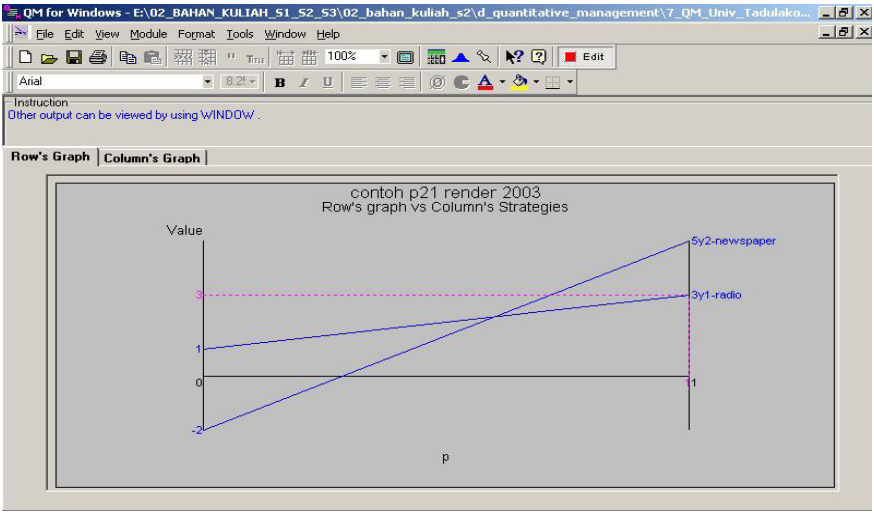
$\frac{8}{1} * 1 + \frac{3}{1} * 10 = \frac{8}{1} = 3.46$

Demikian pula X akan melakukan strategy **4Q+1(1-Q) = 2Q+10Q(1-Q)**

hasilnya Q = $\frac{9}{1}$ dan 1-Q = $\frac{2}{1}$ atau $\frac{9}{1} * 4 + \frac{2}{1} * 1 = \frac{8}{1}$ = 3.46

Pergunaaan Komputer sbb :

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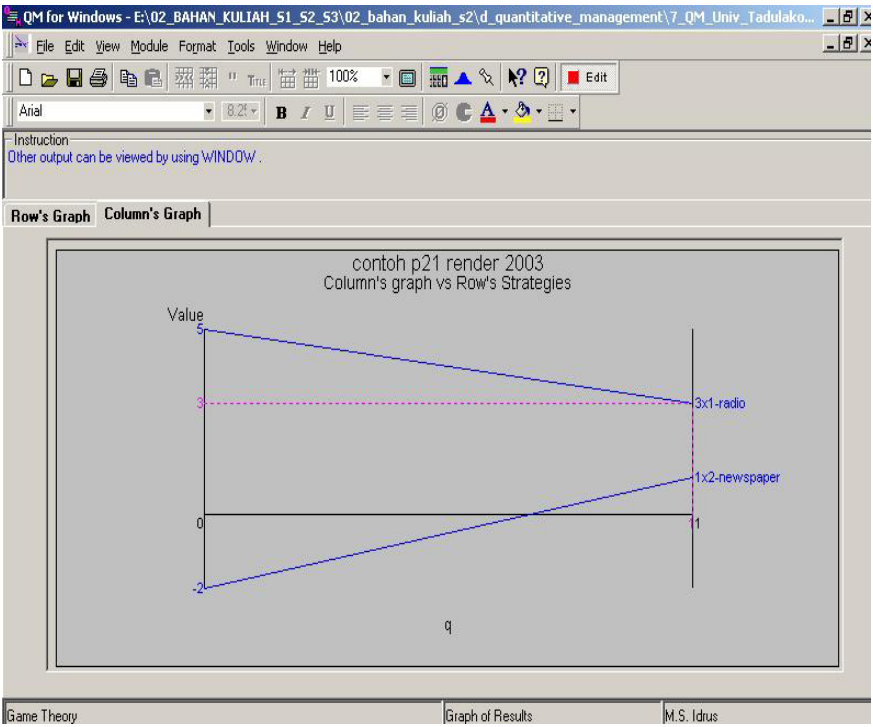
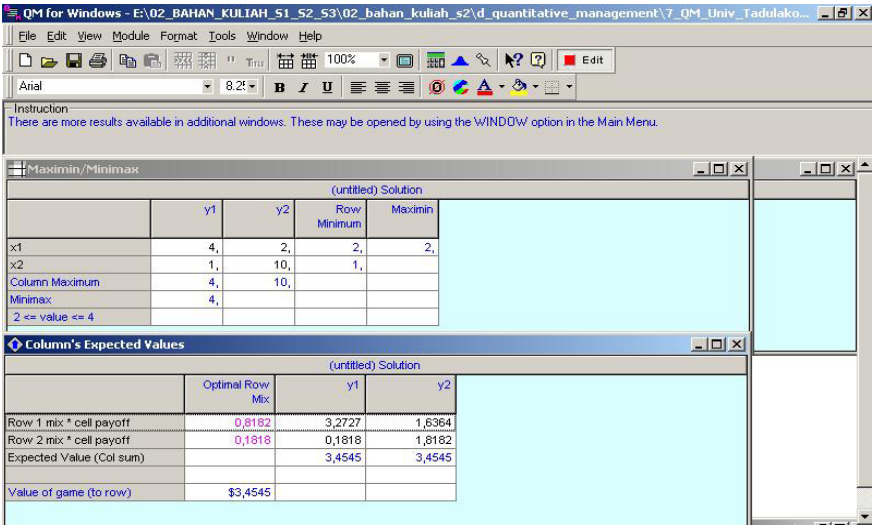
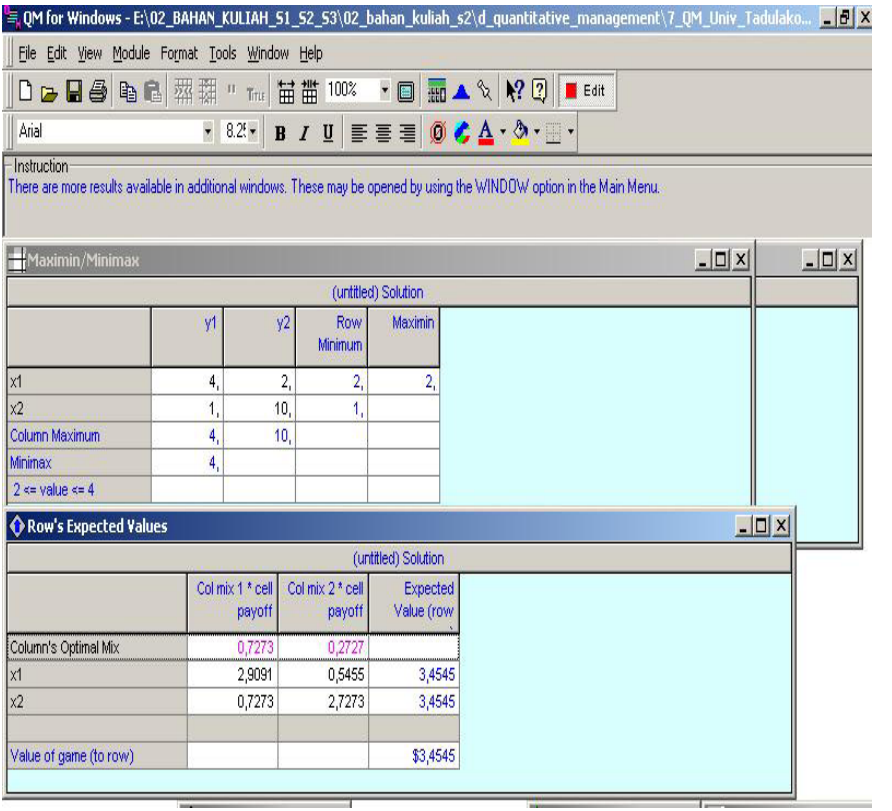
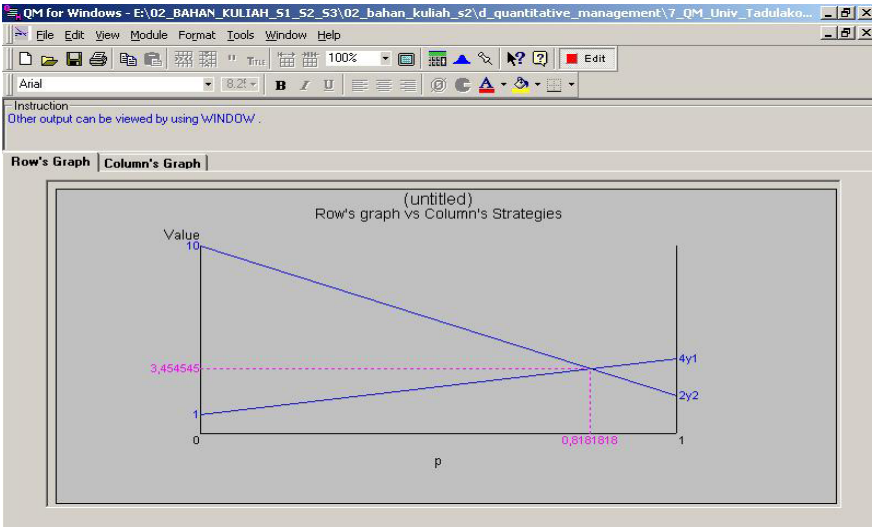
Instruction
Other output can be viewed by using WINDOW .
Row's Graph
Column's Graph
contoh p21 render 2003
Row's graph vs Column's Strategies
Value
5y2-newspaper
3y1-radio
3
1
0
-2
1
p


QM for Windows - E:\02_BAHAN_KULIAH_S1_S2_S3\02_bahan_kuliah_s2\d_quantitative_management\7_QM_Univ_Tadulako...
File Edit View Module Format Tools Window Help
Edit
Arial
Instruction
Other output can be viewed by using WINDOW .
Row's Graph
Column's Graph
contoh p21 render 2003
Column's graph vs Row's Strategies
Value
5
3
0
-2
3x1-radio
1x2-newspaper
1
q
Game Theory
Graph of Results
M.S. Idrus


QM for Windows - E:\02_BAHAN_KULIAH_S1_S2_S3\02_bahan_kuliah_s2\d_quantitative_management\7_QM_Univ_Tadulako...
File Edit View Module Format Tools Window Help
Edit
Arial
Instruction
There are more results available in additional windows. These may be opened by using the WINDOW option in the Main Menu.
Maximin/Minimax
(untitled) Solution
y1 y2 Row Minimum Maximin
x1 4, 2, 2, 2,
x2 1, 10, 1,
Column Maximum 4, 10,
Minimax 4,
2 <= value <= 4
Column's Expected Values
(untitled) Solution
Optimal Row Mix y1 y2
Row 1 mix * cell payoff 0,8182 3,2727 1,6364
Row 2 mix * cell payoff 0,1818 0,1818 1,8182
Expected Value (Col sum) 3,4545 3,4545
Value of game (to row) $3,4545


QM for Windows - E:\02_BAHAN_KULIAH_S1_S2_S3\02_bahan_kuliah_s2\d_quantitative_management\7_QM_Univ_Tadulako...
File Edit View Module Format Tools Window Help
Edit
Arial
Instruction
There are more results available in additional windows. These may be opened by using the WINDOW option in the Main Menu.
Maximin/Minimax
(untitled) Solution
y1 y2 Row Minimum Maximin
x1 4, 2, 2, 2,
x2 1, 10, 1,
Column Maximum 4, 10,
Minimax 4,
2 <= value <= 4
Row's Expected Values
(untitled) Solution
Col mix 1 * cell payoff Col mix 2 * cell payoff Expected Value (row
Column's Optimal Mix 0,7273 0,2727
x1 2,9091 0,5455 3,4545
x2 0,7273 2,7273 3,4545
Value of game (to row) $3,4545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File Edit View Module Format Tools Window Help
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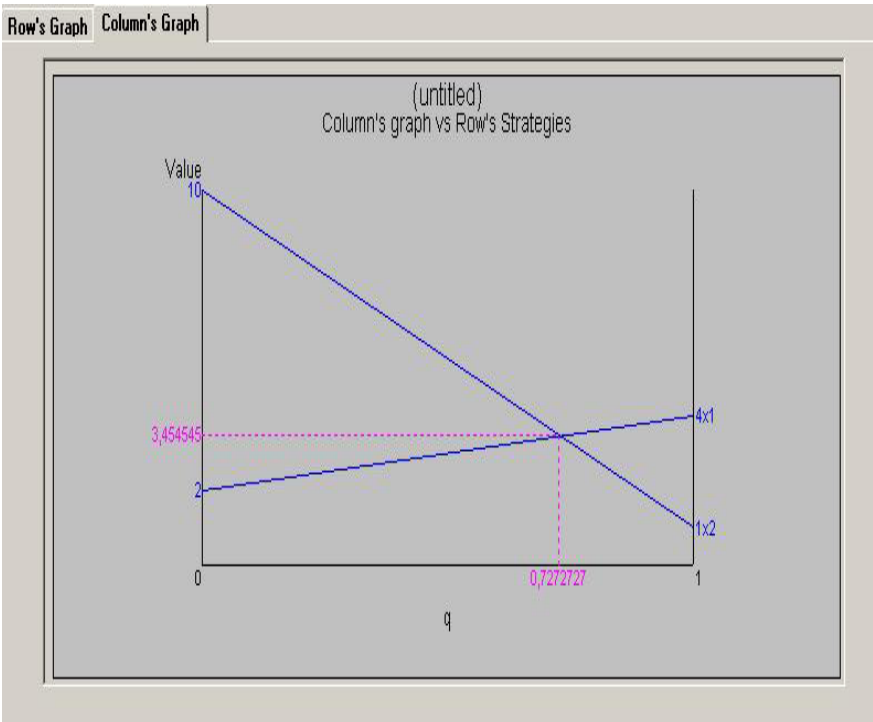
Arial
Instruction
Other output can be viewed by using WINDOW .
Row's Graph
Column's Graph
(untitled)
Row's graph vs Column's Strategies
Value
10
3,454545
1
0
0,8181818
1
4y1
2y2
p


Row's Graph
Column's Graph
(untitled)
Column's graph vs Row's Strategies
Value
10
3,454545
2
0
0,7272727
1
4x1
1x2
q

Bab 15 DYNAMIC PROGRAMMING

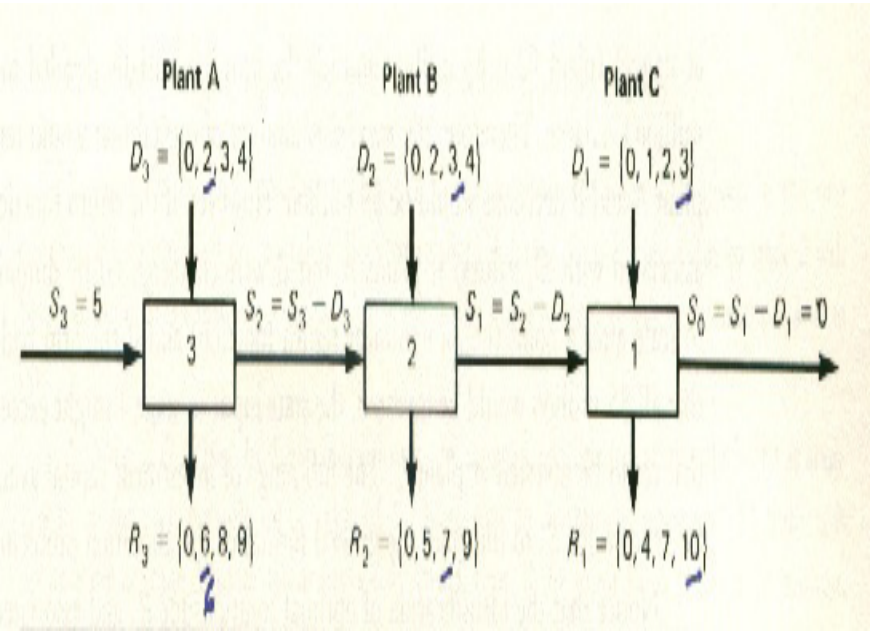
(p570 Lee More, and Taylor Management Science, 1993 – pada text-book terbaru nateri ini sudah tidak ada lagi / dihilangkan)

Model ini sangat berdekatan dengan model decision tree analysis yang disebut juga dengan multistage (sub problems)

Misalkan sebuah perusahaan mempnyai pabrik di A (Alanta) B (Baltimoore) dan C (Chicago). Perusahaan menyususn budget sebesar $5juta untuk plant improvement, dan budget tersebut harus diallokasikan pada ketiga pabrik tersebut. Untuk pabrik A dan B harus diallokasikan paling sedikit $2 juta masing masing, dan maximum invstasi untuk A atau B adalah $4 juta dan C $3 juta. Jika diallokasikan pada ketiga pabrik tersebut diprediksi akan menghasilkan sbb :

Decision alternatives ($juta)	Hasil / return yang akan diperoleh jika alternative tersebut diterapkan pada masing masing plant ($juta) adalah sbb :		
	A	B	C
1	-	-	4
2	6	5	7
3	8	7	10
4	9	9	

Maka dapat disusun suatu bagan sbb :



Decision	A					B					C			
	-	-	2	3	4	-	-	2	3	4	0	1	2	3
Return	-	-	6	8	9	-	-	5	7	9	0	4	7	10

Hasil simulasi sbb :

$juta	C	B	A	Jumlah	Keterangan
0	-	-	-	0	
5	3(10)	2(5)	-	15	Investasi pada B = 2 return = 6 C = 3 return = 10 total 15
5	3 (10)	-	2(6)	16	
5	**1(4)**	**2(5)**	**2(6)**	**15**	**Maximum investasi**
5	1(4)	0	4(9)	13	
5	1(4)	4(9)		13	
5	2(7)	3(7)		14	
5	**2(7)**		**3(8)**	**15**	**Maximum investasi**

Daftar Pustaka

Render B, and Stair jr R.M, 2000, **Quantitative Analysis for Management**, 7th ed Prentice Hall , New Jersey (lihat juga www.prenhall.com/render)

Render B, and Stair jr R.M, 2000, **Quantitative Analysis for Management**, 8th edition 2003, Prentice Hall , New Jersey (lihat juga www.prenhall.com/render)

Render B, Stair jr R M and Hanna M E (2006). ***Quantitative Analysis for Management***, (9th edition) Prentice Hall. ISBN #0-13-066952-0. ***QM for Windows software***

Render B, Stair jr R M and Hanna M E (2012). ***Quantitative Analysis for Management***, (11th edition) Prentice Hall. ISBN #0-13-066952-0. ***QM for Windows software***

Buku ini merupakan revisi edisi sebelumnya yang diterbitkan dengan ISBN 978-979-17971-9-1 pada tahun 2009. Edisi sebelumnya masih perlu disempurnakan lagi untuk memberikan materi yang sesuai dengan perubahan lingkungan dunia usaha.

Materi juga tetap dipersiapkan untuk membantu mahasiswa yang sedang menempuh mata kuliah 'quantitative analysis for management' atau disebut juga dengan 'operation research' dengan textbook standard dari Render B, Stair jr R M and Hanna M E yang diterbitkan pada tahun 2003 atau 2006, dan 2012) yang berjudul *Quantitative Analysis for Management*, (8th atau 9th maupun 11th edition) bersama dengan text tersebut dilampirkan software -*QM for Windows versi 4*.

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