D_W: ships tonnage (DWT)
R : load factor
D_a: days in voyage

The Table 3-7 shows an example of the estimated coefficients of the linear function about tankers. In this table, the decreasing tendency of the coefficient with respect to voyage distance means that larger tankers become relatively more economic as the voyage distance increases.

3.4 Distribution Model

The method introduced here is used to determine the proportion of tonnage on each route and each size.

The two kinds of distribution, routes and size categories are related to each other, mainly because the number of voyages differs according to the chosen route. This difference has an effect on the displacement of ships and, on the shipping cost through the shipping market. Therefore further analysis will develop the method considering this relationship, but at present, the fleet mix relevant to the trade flow is assumed to be given. Then the problem is to determine the proportion of tonnage on alternative routes when the vessel size is given. In the shipping costs section, the linear function was shown with its coefficients in the following form.

$C = a + b \cdot d$

a, b: coefficients
d : voyage distance

This shipping cost is a mixture of the cost components which vary according to the ships, routes and so on. Then the cost C should be assumed to be distributed with C (= a+b·d) as the average.

On the other hand, the vessel is assumed to choose the route which is cheaper in shipping costs when the alternative routes are given. Let C_A and C_B be the shipping costs on route A and route B respectively. Which route is chosen depends upon the sign of $(C_A - C_B)$. If $C_A \geqq C_B$, route B is chosen, and conversely route A is chosen.

But, since C_A and C_B both have the distribution as mentioned above, $(C_A - C_B)$ also has the distribution. Therefore the integration of the probability of the case in which C_B is cheaper than C_A gives the proportion of occasions when route B is preferred to route A (the shaded portion of Figure 3.2).

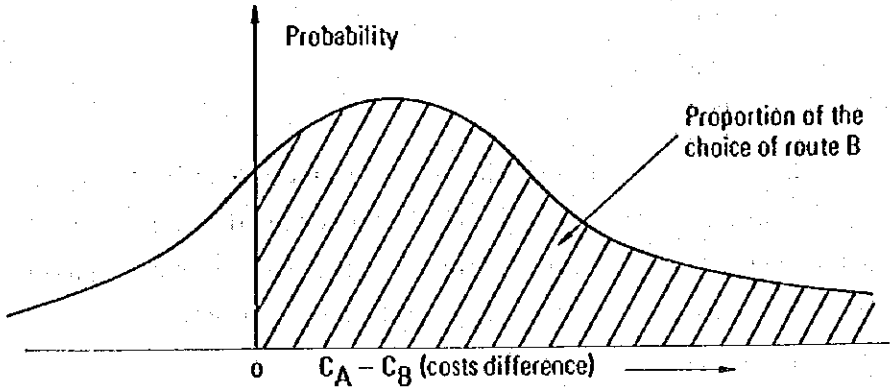


Fig. 3.2 Probabilistic Route Choice Model

3.5 Forecasting Procedure: A Simplified Case Study

In this section, an example of forecasting the Canal transit is shown based on the simplified model.

(1) Assumptions

For simplicity the following is assumed.

(a) Relevant trade flows are composed of only three pairs: from A.G. (Arabian Gulf) to N.E. (North Europe), from A.G. to M.S. (Mediterranean Sea) and from A.G. to U.S.A.

(b) The commodity understudy is only one kind, i.e. crude oil, which means that only tanker transits will be analyzed.

(c) Each volume of the trade flow is given by the preceding forecast of world economy and seaborne trade.

(d) The fleet mix on the routes relevant to the Canal is roughly specified reflecting the world fleet mix.

(e) The development phase and maximum size of ships capable of passing through the Canal at each phase are shown in Table 3.1.

Table 3.1 Development Phase and Maximum Capable Size of Ship

Development Phase		Draught (feet)	Wet Cross-section (m^2)	Maximum Size (1,000 DWT)	
				Laden	Ballast
Present	I	38	1,800	60	200
First Stage	II	53	3,600	150	330
Second Stage	III	67	5,000	260	700

(2) External Data and Results

External data and the results calculated from them are summarized in the following table: from table 1 to 7 are the external data and from 8 to 21 are the results.

Table 3.2 A Summary of Tables

Table No.	Table Name	Notes
Table 1	Development Phases and Maximum Capable Size of Ship	External Data
Table 2	Trade Flows Relevant to Canal	External Data
Table 3	Fleet Structure Relevant to Canal	External Data
Table 4	Canal Charge per ton of Cargo in each Condition	External Data
Table 5	Canal dues per Tanker Transit	External Data
Table 6	Route Distance and Number of Voyages per Year	External Data
Table 7	Cost Estimation Equations	External Data
Table 8	Route Cost of Shipping per ton of Cargo	From Table 4, 6, 7
Table 9	Proportion of Route Choice	From Table 8
Table 10	Proportion of Route Choice at each Phase	From Table 1, 9
Table 11	Traffic Volume for each Route on each Trade Flow at each Phase	From Table 2, 3, 10
Table 12	Traffic Volume via Canal and via Cape	From Table 11
Table 13	Number of Ship Trips for each Route at each Phase	From Table 3, 11
Table 14	Number of Ships Through the Canal	From Table 13
Table 15	Ship Number Requirement on each Route at each Phase	From Table 13, 6
Table 16	Tonnage Requirement on each Route at each Phase	From Table 15, 3
Table 17	Total Tonnage Requirement	From Table 16
Table 18	Tonnage Displacement for each Size of Ship	From Table 3, 17
Table 19	Revenue from Ships Through the Canal	From Table 5, 14

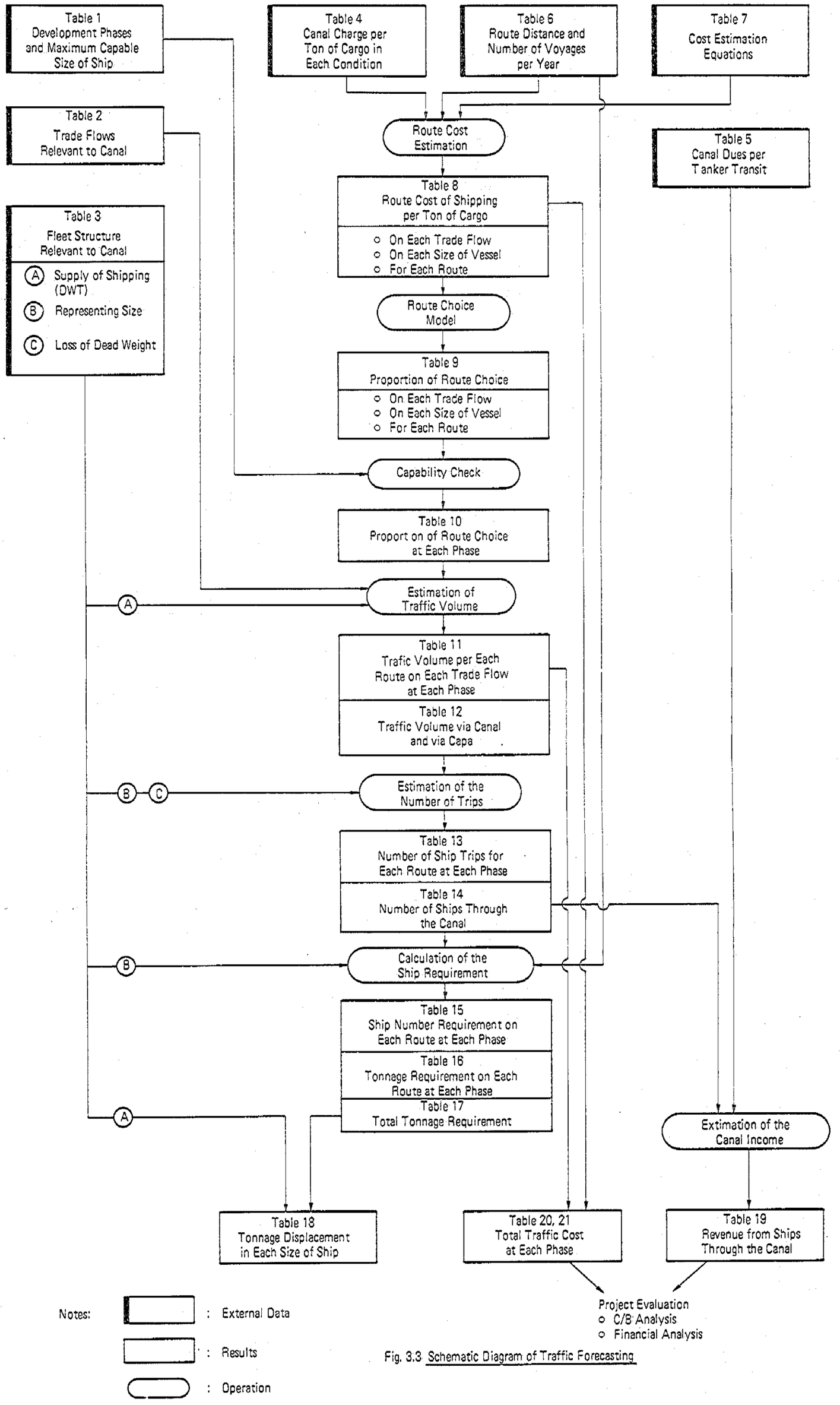


Fig. 3.3 Schematic Diagram of Traffic Forecasting

(3) Example of Forecast

An example of the detailed forecasting procedure is as follows.

1) Trade flows

Trade flows of crude oil relevant to the Canal are given in Table 3.3.

Table 3.3 Trade Flows

(Unit: 10^6 t)

Origin ——→ Destination	Volume
A. Gulf ——→ N. Europe	310
A Gulf ——→ Mediterranean	50
A Gulf ——→ U.S.A.	110
Total	470
Notes: Estimated Volume (1980 of Cru e Oil)	

2) Classification of tanker sizes

The size of tankers should be classified in such a way that the ship types capable of transiting the Canal in either laden or ballast conditions will be properly grouped corresponding to each of the Development phases. Table 3. is an example of the tanker size classification that was made according to this criterion.

Table 3.4 Fleet Structure Relevant to the Canal

Tanker Size (000 DWT)	Representative Size (000 DWT)	DWT (10^6 DWT)	Share (%)	Capable or Not			R. Size x Ratio
				Phase I	Phase II	Phase III	
0 – 60	40	15	15	B, L	B, L	B, L	36
60 – 150	105	22	22	B	B, L	B, L	95
150 – 200	175	9	9	B	B	B, L	158
200 – 260	230	22	22	X	B	B, L	207
260 – 330	295	20	20	X	B	B	266
330 – 700	500	12	12	X	X	B	450

Notes: Ratio = 0.9, Loss of Dead Weight

L, B denote that tankers of corresponding size can transit the Canal at corresponding phases if they are in laden and in ballast respectively. Tankers maked with X cannot pass through.

Tankers in each category are assumed to have the same characteristics such as sizes, shipping costs and so on. Take the category, 200-260 (000 DWT), for instance, Table 3.4 shows that all tankers in the category can pass through the Canal if they are in ballast at Phase II and even if they are laden at Phase III.

3) The fleet mix

As mentioned in the distribution model section, the fleet mix relevant to the Suez Canal is assumed to be given without the consideration of the route choice. And the fleet mix assumed relevant to the Suez Canal is shown in Table 3.3.

4) Calculation of shipping costs

The calculation of shipping costs is based on the estimation equation as mentioned above in the shipping costs section (3.3).

$C = a + b \cdot d$

C = shipping costs/per cargo ton

d : voyage

a,b: coefficients

Voyage distance of relevant route needed to calculate the costs is shown in Table 3.7. The numbers of voyages per year are also listed in the table and these figures are used later.

Table 3.7 Route Distance and Number of Voyages per Year

O – D	Distance Mile (One Way)		Number of Voyages per Year		
	Via Suez	Via Cape	S/S	S/C	C/C
A.G. – N. Europe	6,560	11,203	8.65	6.94	5.24
A.G. – Mediterranean	4,705	11,069	11.61	8.47	5.34
A.G. – U.S.A.	8,668	12,039	6.70	5.82	4.94

Note: S/S, C/S and C/C imply "via the Suez Canal laden and in ballast, " " via the Cape laden and via the Suez Canal in ballast, " and " via the Cape both laden and in ballast," respectively.

Furthermore, the estimated coefficients in each size category are shown in Table 3.8.

As explained in the distribution model section, the costs of each ship size have distribution. Then, it is assumed that the costs distribution is normal with parameter values of; 1) average C= a+b·d and 2) standard deviation, 0.5.

This distribution is considered later in the route choice section.

Table 3.8 Cost Estimation Equations

Ship Size (000 DWT)	Representing Size (000 DWT)	Cost Model	
		Average Cost	Standard Deviation
0 – 60	40	C = 1.27 + 0.60t	0.5
60 – 150	105	C = 0.70 + 0.40t	0.5
150 – 200	175	C = 0.61 + 0.34t	0.5
200 – 260	230	C = 0.58 + 0.30t	0.5
260 – 330	295	C = 0.57 + 0.27t	0.5
330 –	500	C = 0.50 + 0.18t	0.5

Table 3.9 shows the result of the costs calculation obtained by using the equation, with voyage distance as vairable and, the coefficients. The Canal due is added to the value of the cost equation. The canal due per cargo ton that is assumed is shown in Table 3.5.

Table 3.9 Route Cost of Shipping per Ton of Cargo

(Unit: $/Ton)

O – D / Route / Ship Size / Distance	A.G. – N. Europe			A.G. – E. Mediterranean			A.G. – U.S.A.		
	Via Cape	Via Suez		Via Cape	Via Suez		Via Cape	Via Suez	
		Laden	Ballast		Laden	Ballast		Laden	Ballast
	11.203	6.560		11.069	4.705		12.039	8.668	
0 – 60	7.99	7.21	6.21	7.91	6.09	5.09	8.49	8.47	7.47
60 – 150	5.18	5.32	4.32	5.13	4.58	3.58	5.52	6.17	5.17
150 – 200	4.42	4.84	3.84	4.37	4.21	3.21	4.70	5.56	4.56
200 – 260	3.94	4.55	3.55	3.90	3.99	2.99	4.19	5.18	4.18
260 – 330	3.59	4.34	3.34	3.56	3.84	2.84	3.82	4.91	3.91
330 –	2.52	3.68	2.68	2.49	3.35	2.35	2.67	4.06	3.06

Notes: (1) Including canal dues
(2) One way costs ($/Ton)

Table 3.5 Canal Due per Cargo Ton ($/Ton)

Laden	2.0
In Ballast	1.0

5) Canal dues per tanker transit

The canal dues for a unit S.C.N.R.T. differ according to the loading condition. And the relationship between S.C.N.R.T. and D.W.T. is assumed to be represented as the following equation from empirical data.

$$S.C.N.R.T. = 0.357 \times (D.W.T.)^{1.03}$$

We can then calculate the Canal dues for a unit transit of the tanker according to the loading condition and its D.W.T. size. These calculated dues are shown in Table 3.6.

Table 3.6 Canal Due per Tanker Transit

(Unit: $/Trip)

Size (000 DWT)	Representing Size (DWT)	#2 S.N.T.	Due #1/Transit	
			Laden	In Ballast
0 – 60	40,000	19,624	36,030	28,828
60 – 150	105,000	53,026	97,356	77,895
150 – 200	175,000	89,742	164,766	121,831
200 – 260	230,000	128,068	235,133	188,132
260 – 330	295,000	153,668	282,134	225,738
330 –	500,000	264,778	486,132	388,959

#1 Due = 1.611 SDR (1.836[#3] $) x S.N.T. (Laden)
1.289 SDR (1.469 $) x S.N.T. (in Ballast)

#2 S.C.N.R.T. = 0.357 x (D.W.T.) $^{1.03}$

#3 based on the exchange rate at January 1, 1977.

6) Route choice without the Canal regulations

When the tanker size is given, the proportions of tonnage which the tanker of that size carries on each relevant route is determined by using the distribution model and the shipping costs distribution. To follow the distribution model mentioned above, we need the distribution of the difference of shipping costs on alternative routes. It was assumed that the shipping costs of each size of tanker and each route follow the normal distribution, and are mutually independent.

Then the distribution of the cost difference follows the normal distribution with the difference between the averages of alternative routes as the average of the new distribution and the squared sum of standard deviations as the variance.

$$Cc \sim N(\overline{Cc}, Sc)$$
$$Cs \sim N(\overline{Cs}, Ss) \Longrightarrow Cc - Cs \sim N(\overline{Cc} - \overline{Cs}, \sqrt{S_C^2 + S_S^2})$$

N (a, b) represents the normal distribution with average a and standard deviation b.

Fig. 3.4 Normal Distribution of Shipping Costs

In this Fig, C_C, C_S denote the shipping costs via the Cape and via the Suez Canal respectively.

The shipping costs calculation result in Table 3.8 is used to determine the distribution of costs difference on alternative routes. And this distribution is normal and its average (μ) is $\overline{C}_C - \overline{C}_S$ ($\overline{C}_C$, $\overline{C}_S$ are indicated in Table 3.9), and its standard deviation (σ) is $\sqrt{2}/2$ ($\sqrt{(\frac{1}{2})^2 + (\frac{1}{2})^2}$, the standard deviation of each cost has been assumed to be 0.5).

We can then obtain the proportion of occasions when the Suez Canal is preferred by integrating the positive region of the distribution (shaded portion of Figure 3.5).

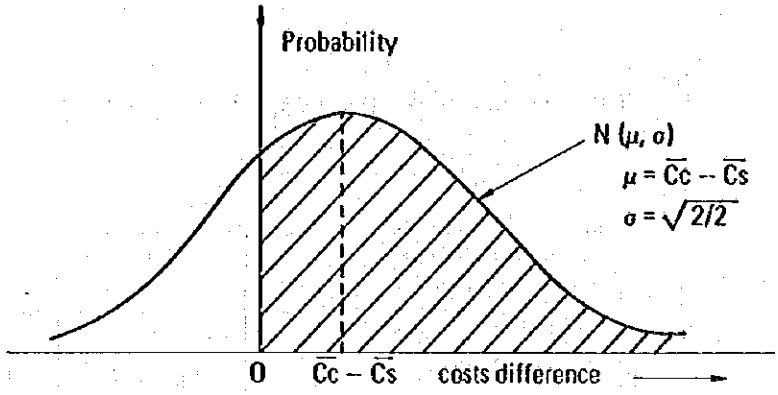


Fig. 3.5 The Proportion of Tonnage through the Suez Canal

Let f(x) be the probability of the case in which x is the costs difference and the integrated proportion is represented as $\int_0^{\frac{\bar{C}c-\bar{C}s}{\sigma}} f(x)\,dx + 0.5$, where f(x) is represented as $\frac{1}{\sqrt{2\pi}\sigma}$ exp $[\,-\frac{(x-\mu)^2}{2\sigma^2}\,]$.

For convenience, this integration should be converted into one using the normal distribution with average 0 and standard deviation 1. Then the converted integration is as follows.

$$\int_0^{(\bar{C}c-\bar{C}s)/\frac{\sqrt{2}}{2}} g(x)dx + 0.5$$

, where $g(x) \sim N\ (0,1)$.

The normal distribution table in which the values of the integration $\int_0^x g(x)\,dx$ are listed when g(x) follows N (0,1) helps us to make the above calculation.

Table 3.10 shows the proportion of the choice on each route obtained by these calculations. In the table σ/T represents the standard deviation which is used to convert the integration and is assumed to be $\sqrt{2}$ /2 here.

Table 3.10 Proportion of Route Choice on Each Trade Flow

(Unit: %)

O-D	Route / Ship Size	Northbound (Laden)			Southbound (Ballast)		
		$\bar{C}c - \bar{C}s/o$	Proportion		$\bar{\bar{C}}c - \bar{\bar{C}}s/o$	Proportion	
			Via Suez	Via Cape		Via Suez	Via Cape
A.G. – N. Europe	0 – 60	1.11	87	13	2.54	99	1
	60 – 150	-0.20	42	58	1.23	89	11
	150 – 200	-0.60	28	72	0.82	79	21
	200 – 260	-0.87	20	80	0.56	71	29
	260 – 330	-1.07	15	85	0.36	64	36
	330 –	-1.66	5	95	-0.23	41	59
A.G. – Mediterranean	0 – 60	2.60	99	1	4.02	100	0
	60 – 150	0.79	78	22	2.21	99	1
	150 – 200	0.23	59	41	1.66	95	5
	200 – 260	-0.13	45	55	1.30	90	10
	260 – 330	-0.40	35	65	1.03	85	15
	330 –	-1.23	11	89	0.20	58	42
A.G. – U.S.A.	0 – 60	0.03	51	49	1.45	93	7
	60 – 150	-0.93	18	82	0.50	69	31
	150 – 200	-1.22	11	89	0.20	58	42
	200 – 260	-1.41	8	92	0.01	51	49
	260 – 330	-1.56	6	94	-0.13	45	55
	330 –	-1.99	2	98	-0.56	29	71

7) Route choice with the Canal regulations

Here, the Canal regulations with respect to the maximum size that is capable of passing through are introduced to determine the actual proportions on each route.

Furthermore, routes are defined as round voyages instead of one way routes.

The relevant routes are the following.

(i) via the Suez Canal both laden and in ballast (S/S).
(ii) via the Cape laden and via the Suez Canal in ballast (C/S)
(iii) via the Cape both laden and in ballast (C/C).

Then the proportions are determined in the following way, taking account of the result of route choice without the regulations (Table 3.10 and the capability of each size of tanker at each expansion phase (Table 3.4).

(i) if tankers cannot pass through the Suez Canal either laden or in ballast, they take the round voyage C/C.

(ii) if the tanker can pass through the Suez Canal only in ballast, it may have the voyage C/S or C/C. These shares follow the proportions between via Cape and via Suez Canal in ballast that are the result of route choice without regulations.

(iii) if the tanker can pass through the Suez Canal both laden and in ballast, the proportion of the voyage S/S is equal to that of choice for the Suez Canal on a northbound trip without regulations on the assumption that those tankers which use the Suez Canal on a northbound trip (laden) necessarily pass through the Suez Canal on a southbound trip (in ballast). The proportion for the Suez Canal on a southbound trip without regulations includes the voyage C/S and S/S. We can then obtain the proportion for the C/S by subtracting the proportion for S/S from the proportion for the Suez Canal on a southbound trip. The rest is the proportion for the voyage C/S.

Table 3.10 shows the result of the proportion for round voyages at each expansion phase considering the Canal regulations.

8) Traffic volume on each route

The actual traffic volume is obtained by allocating the trade flow volume (Table 3.3) with corresponding proportions. Firstly, total volume is distributed between tanker sizes according to the proportion assumed in Table 3.4.

Then the volume of each size is further distributed between the voyage routes according to the result in Table 3.11. Table 3.12 shows this traffic volume distributed between tanker sizes and voyage routes.

Table 3.11 Proportion of Route Choice at Each Phase for a Ship Capable of Passing through the Canal

O.D.	Ship Size	World Fleet Mix (%)	Proportion of Route Choice at Each Phase (%)			
			Phase	S/S	C/S	C/C
A.G. – N. Europe	0 – 60	15	I	0.87	0.13	0.01
			II	0.87	0.13	0.01
			III	0.87	0.13	0.01
	60 – 150	22	I	0.0	0.89	0.11
			II	0.42	0.47	0.11
			III	0.42	0.47	0.11
	150 – 200	9	I	0.0	0.79	0.21
			II	0.0	0.79	0.21
			III	0.28	0.52	0.21
	200 – 260	22	I	0.0	0.0	1.00
			II	0.0	0.71	0.29
			III	0.20	0.52	0.29
	260 – 330	20	I	0.0	0.0	1.00
			II	0.0	0.64	0.36
			III	0.0	0.64	0.36
	300 –	12	I	0.0	0.0	1.00
			II	0.0	0.0	1.00
			III	0.0	0.41	0.59
A.G. – Mediterranean	0 – 60	15	I	0.99	0.01	0.0
			II	0.99	0.01	0.0
			III	0.99	0.01	0.0
	60 – 150	22	I	0.0	0.99	0.01
			II	0.78	0.21	0.01
			III	0.78	0.21	0.01
	150 – 200	9	I	0.0	0.95	0.05
			II	0.0	0.95	0.05
			III	0.59	0.36	0.05
	200 – 260	22	I	0.0	0.0	1.00
			II	0.0	0.90	0.10
			III	0.45	0.45	0.10
	260 – 330	20	I	0.0	0.0	1.00
			II	0.0	0.85	0.15
			III	0.0	0.85	0.15
	330 –	12	I	0.0	0.0	1.00
			II	0.0	0.0	1.00
			III	0.0	0.58	0.42
A.G. – U.S.A.	0 – 60	15	I	0.51	0.41	0.07
			II	0.51	0.41	0.07
			III	0.51	0.41	0.07
	60 – 150	22	I	0.0	0.69	0.31
			II	0.18	0.51	0.31
			III	0.18	0.51	0.31
	150 – 200	9	I	0.0	0.58	0.42
			II	0.0	0.58	0.42
			III	0.11	0.47	0.42
	200 – 260	22	I	0.0	0.0	1.00
			II	0.0	0.51	0.49
			III	0.08	0.43	0.49
	260 – 330	20	I	0.0	0.0	1.00
			II	0.0	0.45	0.55
			III	0.0	0.45	0.55
	330 –	12	I	0.0	0.0	1.00
			II	0.0	0.0	1.00
			III	0.0	0.29	0.71

Table 3.12 Traffic Volume on Each Route at Each Phase

O.D.	Ship Size	Traffic Volume mmt/year									
		Volume mmt	S/S			C/S			C/C		
			I	II	III	I	II	III	I	II	III
A.G. – N. Europe	0 – 60	46.5	40.3	40.3	40.5	5.9	5.9	5.9	0.3	0.3	0.3
	60 – 150	68.2	0	28.6	28.6	60.5	31.9	31.9	7.7	7.7	7.7
	150 – 200	27.9	0	0	7.7	22.1	22.1	14.4	5.8	5.8	5.8
	200 – 260	68.2	0	0	13.3	0	48.5	35.2	68.2	19.7	19.7
	260 – 330	62.0	0	0	0	0	39.7	39.7	62.0	22.3	22.3
	330 –	37.2	0	0	0	0	0	15.2	37.2	37.2	22.0
	Total	310.0	40.3	68.9	90.1	88.6	148.1	142.3	181.1	93.0	77.8
A.G. – Mediterranean	0 – 60	7.5	7.5	7.5	7.5	0	0	0	0	0	0
	60 – 150	11.0	0	8.6	8.6	10.8	2.3	2.3	0.2	0.2	0.2
	150 – 200	4.5	0	0	2.7	4.3	4.3	1.6	0.2	0.2	0.2
	200 – 260	11.0	0	0	4.9	0	9.9	5.0	11.0	1.1	1.1
	260 – 330	10.5	0	0	0	0	8.5	8.5	10.0	1.5	1.5
	330 –	6.0	0	0	0	0	0	3.5	6.0	6.0	2.5
	Total	50.5	7.5	16.0	23.6	15.2	24.9	20.8	27.4	9.0	5.5
A.G. – U.S.A.	0 – 60	16.5	8.5	8.5	8.5	6.8	6.8	6.8	1.2	1.2	1.2
	60 – 150	24.2	0	4.3	4.3	16.7	12.4	12.4	7.5	7.5	7.5
	150 – 200	9.9	0	0	1.1	5.8	5.8	4.6	4.1	4.1	4.1
	200 – 260	24.2	0	0	2.0	0	12.3	10.3	24.2	11.9	11.9
	260 – 330	22.0	0	0	0	0	9.9	9.9	22.0	12.1	12.1
	330 –	13.2	0	0	0	0	0	3.8	13.2	13.2	9.4
	Total	110.0	8.5	12.8	15.9	29.2	47.1	47.8	72.3	50.1	46.3

Table 3.13 Traffic Volume via Canal and via Cape

(Unit: m.m.t/year)

Phase	O.D.	via Suez	via Cape	Total
I	A.G. – N. Europe	40.3	269.7	310.0
	A.G. – Mediterranean	7.5	42.5	50.0
	A.G. – U.S.A.	8.5	101.5	110.0
	Total	56.2	413.8	470.8
II	A.G. – N. Europe	68.9	241.1	310.0
	A.G. – Mediterranean	16.0	34.0	50.0
	A.G. – U.S.A.	12.8	97.2	110.0
	Total	97.8	372.2	470.0
III	A.G. – N. Europe	90.0	220.0	310.0
	A.G. – Mediterranean	23.6	26.4	50.0
	A.G. – U.S.A.	15.9	94.1	110.0
	Total	129.5	340.5	470.0

via Suez: S/S
via Cape: C/C + C/S

9) Number of ship trips

When the traffic volume on each route is given, the number of ship trips needed to carry it can be obtained by dividing the volume by the transportation capacity of the vessel that is represented as the size of tanker (DWT) multiplied by the load factor R (1.- loss of D.W. ratio). Then the following equation gives the number of ship trips.

Trip number = traffic volume/D.W.T. x R

The result of the calculation of the number is shown in Table 3.14. Furthermore, Table 3.15 shows the number of ships passing through the Suez Canal according to the loading condition. They are calculated by the following equations.

The number of ships (Northbound : laden) = N (S/S)
The number of ships (Southbound : in ballast) = N(S/S) + (C/S), where N(S/S), N(C/S) means the number of ships on S/S trips and C/S trips respectively.

10) Revenue from ships passing through the Canal

The numbers of ships passing through the Canal in the table give the revenue when multiplied by the corresponding Canal dues per tanker transit. The result of the calculation of revenue is shown in Table 3.20.

11) Ship requirement

The number of ships as the stock needed to carry the traffic volume calculated above is obtained by dividing the number of trips (Table 3.14) by the average number of voyages (Table 3.7). And to represent the demand for the ships totally, the ships tonnage is used. This is the sum of the needed number of ships of each size category multiplied by size.

The number of ships = The number of trips/the average number of voyages.

Ships tonnage = $\sum_k N_k \cdot (D.W.T.)_k$,

where N_k, $(D.W.T.)_k$ represents the needed number and average D.W.T. of K size of ships respectively.

Table 3.16 and Table 3.17 show the calculated requirement for the number of ships and ships tonnage respectively. Table 3.18 also shows the total ships tonnage required for the trade flow relevant to the Suez Canal.

12) Tonnage displacement

The ship tonnage required to carry the traffic volume should be compared with the present ship tonnage. The comparison shown in Table 3.18 gives the ship displacement that will have effect on the shipping costs through the shipping market. However, this effect has not been considered in the present analysis.

Table 3.14 Number of Ship Trips on Each Route at Each Phase

O.D.	Ship Size	No. of Trips (Round Trips)									
		Sum	S/S			C/S			C/C		
			I	II	III	I	II	III	I	II	III
A.G. – N. Europe	0 – 60	1,293	1,120	1,120	1,120	165	165	165	8	8	8
	60 – 150	721	0	303	303	640	337	337	81	81	81
	150 – 200	178	0	0	49	141	141	92	37	37	37
	200 – 260	330	0	0	64	0	234	170	330	95	95
	260 – 330	234	0	0	0	0	150	150	234	84	84
	330 –	83	0	0	0	0	0	34	83	83	49
	Total	2,839	1,120	1,423	1,536	946	1,026	947	771	387	354
A.G. – Mediterranean	0 – 60	208	207	207	207	1	1	1	0	0	0
	60 – 150	117	0	91	91	115	24	24	2	2	2
	150 – 200	28	0	0	17	27	27	10	1	1	1
	200 – 260	53	0	0	24	0	48	24	53	5	5
	260 – 330	38	0	0	0	0	32	32	38	6	6
	330 –	13	0	0	0	0	0	8	13	13	6
	Total	457	207	298	339	143	132	99	107	28	20
A.G. – U.S.A.	0 – 60	458	235	235	235	189	189	189	34	34	34
	60 – 150	256	0	46	46	176	131	131	80	80	80
	150 – 200	63	0	0	7	37	37	29	26	26	26
	200 – 260	117	0	0	10	0	59	50	117	58	58
	260 – 330	83	0	0	0	0	37	37	83	46	46
	330 –	29	0	0	0	0	0	9	29	29	21
	Total	1,006	235	281	297	402	453	445	369	273	264

Table 3.15 Number of Ships Passing through the Canal (Summary)

(Unit: O.D. Trip/Year)

Phase	Ship Size (000 DWT)	Northbound (Laden)	Southbound (Ballast)	Total
I	0 – 60	1,562	1,917	3,479
	60 – 150	0	931	931
	150 – 200	0	204	204
	200 – 260	0	0	0
	260 – 330	0	0	0
	330 –	0	0	0
	Total	1,562	3,053	4,615
II	0 – 60	1,562	1,917	3,479
	60 – 150	440	931	1,371
	150 – 200	0	204	204
	200 – 260	0	341	341
	260 – 330	0	219	219
	330 –	0	0	0
	Total	2,001	3,612	5,614
III	0 – 60	1,562	1,917	3,479
	60 – 150	440	931	1,371
	150 – 200	73	204	277
	200 – 260	98	341	439
	260 – 330	0	219	219
	330 –	0	50	50
	Total	2,172	3,662	5,834

Southbound: S/S + S/C Northbound: S/S

Table 3.16 Ship Number Requirement on Each Route at Each Phase

O.D.	Ship Size	A.V. (D.W.T.)	Number of Ship (Ships)								
			S/S			C/S			C/C		
			I	II	III	I	II	III	I	II	III
A.G. – N. Europe	0 – 60	40	129.4	129.4	129.4	23.7	23.7	23.7	1.4	1.4	1.4
	60 – 150	105	0	35.0	35.0	92.3	48.6	48.6	15.5	15.5	15.5
	150 – 200	175	0	0	5.6	20.3	20.3	13.2	7.0	7.0	7.0
	200 – 260	230	0	0	7.4	0	33.7	24.5	62.9	18.2	18.2
	260 – 330	295	0	0	0	0	21.5	21.5	44.6	16.0	16.0
	330 – 700	500	0	0	0	0	0	4.9	15.8	15.8	9.3
	Total		129.4	164.5	177.6	136.2	147.8	136.4	147.1	73.9	67.5
A.G. – Mediterranean	0 – 60	40	17.9	17.9	17.9	0.1	0.1	0.1	0.0	0.0	0.0
	60 – 150	105	0	7.8	7.8	13.5	2.8	2.8	0.3	0.3	0.3
	150 – 200	175	0	0	1.5	3.2	3.2	1.2	0.3	0.3	0.3
	200 – 260	230	0	0	2.1	0	5.7	2.8	10.0	1.0	1.0
	260 – 330	295	0	0	0	0	3.8	3.8	7.1	1.1	1.1
	330 – 700	500	0	0	0	0	0.9	0.9	2.5	2.5	1.0
	Total		17.9	25.7	29.2	16.9	15.6	11.7	20.1	5.2	3.7
A.G. – U.S.A.	0 – 60	40	35.1	35.1	35.1	32.5	32.5	32.5	6.9	6.9	6.9
	60 – 150	105	0	6.8	6.8	30.3	22.5	22.5	16.1	16.1	16.1
	150 – 200	175	0	0	1.1	6.3	6.3	5.1	5.3	5.3	5.3
	200 – 260	230	0	0	1.4	0	10.2	8.5	23.7	11.7	11.7
	260 – 330	295	0	0	0	0	6.4	6.4	16.8	9.2	9.2
	330 – 700	500	0	0	0	0	0	1.5	5.9	5.9	4.2
	Total		35.1	41.9	44.4	69.1	77.9	76.5	74.7	55.2	53.5

Table 3.17 Tonnage Requirement on Each Route at Each Phase

O.D.	Ship Size	A.V. DWT (000 DWT)	DEMAND (DWT)								
			S/S			C/S			C/C		
			I	II	III	I	II	III	I	II	III
A.G. – N. Europe	0 – 60	40	5,177	5,177	5,177	949	949	949	57	57	57
	60 – 150	105	0	3,679	3,679	9,688	5,102	5,102	1,630	1,630	1,630
	150 – 200	175	0	0	988	3,544	3,644	2,313	1,222	1,222	1,222
	200 – 260	230	0	0	1,710	0	7,761	5,629	14,461	4,183	4,183
	260 – 330	295	0	0	0	6,354	6,354	13,147	4,732	4,732	4,732
	330 –	500	0	0	0	0	0	2,431	7,888	7,888	4,669
	Total		5,177	8,856	11,555	14,181	23,710	22,777	38,405	19,712	16,492
A.G. – Mediterranean	0 – 60	30	714	714	714	5	5	5	0	0	0
	60 – 150	105	0	821	821	1,422	297	297	33	33	33
	150 – 200	175	0	0	255	561	561	212	47	47	47
	200 – 260	230	0	0	473	0	1,300	652	2,289	227	227
	260 – 330	295	0	0	0	0	0	458	1,248	1,248	522
	330 –	500	0	0	0	0	0	458	1,248	1,248	522
	Total		714	1,535	2,262	1,988	3,271	2,731	5,698	1,878	1,152
A.G. – U.S.A.	0 – 60	30	1,403	1,403	1,403	1,302	1,302	1,302	275	275	275
	60 – 150	105	0	716	716	3,183	2,359	2,359	1,693	1,693	1,693
	150 – 200	175	0	0	187	1,100	1,100	885	931	931	931
	200 – 260	230	0	0	325	0	2,340	1,965	5,443	2,687	2,687
	260 – 330	295	0	0	0	0	1,888	1,888	4,948	2,724	2,724
	330 –	500	0	0	0	0	0	729	2,969	2,969	2,111
	Total		1,403	2,119	2,631	5,584	8,987	9,127	16,260	11,279	10,421

Table 3.18 Total Tonnage Requirement

(Unit: 10^6 DWT)

Phase	Category of Ship Size						
	0 – 60 (000 DWT)	60 – 150	150 – 200	200 – 260	260 – 330	330 –	Total
I	9.9	17.7	7.4	22.2	20.2	12.1	89.4
II	9.9	16.3	7.4	18.5	17.1	12.1	81.3
III	9.9	16.3	7.4	17.9	17.1	10.9	79.1

Table 3.19 Tonnage Displacement of Each Size of Ship

(Unit: 10^5 DWT)

Size		Ship Size						
		0 – 60	60 – 150	150 – 200	200 – 260	260 – 330	330 –	Total
	Fleet (Supply)	15	22	9	22	20	-12	100
Gap	Phase I	5.1	4.3	1.6	-0.2	-0.2	- 0.1	10.6
	Phase II	5.1	5.7	1.6	3.5	2.9	- 0.1	18.7
	Phase III	5.1	5.7	1.6	4.1	2.9	1.1	20.9

Table 3.20 Revenue from Ships Passing Through the Canal

(Unit: 1,000 $/Year)

Phase	Ship Size (000 DWT)	Northbound (Laden)	Southbound (Ballast)	Total
I	0 – 60	56,274	55,261	111,535
	60 – 150	0	72,558	72,558
	150 – 200	0	26,929	26,929
	200 – 260	0	0	0
	260 – 330	0	0	0
	330 –	0	0	0
	Total	56,274	154,748	211,022
II	0 – 60	56,274	55,261	111,535
	60 – 150	42,793	73,558	115,351
	150 – 200	0	26,929	26,929
	200 – 260	0	64,198	64,198
	260 – 330	0	49,334	49,334
	330 –	0	0	0
	Total	99,067	268,280	367,347
III	0 – 60	56,274	55,261	111,535
	60 – 150	42,793	72,558	111,351
	150 – 200	12,006	26,929	38,935
	200 – 260	22,965	64,198	87,164
	260 – 330	0	49,334	49,334
	330 –	0	19,438	19,438
	Total	134,039	287,718	421,757

3.6 Sensitivity Analysis on Tariffs

Sensitivity analysis is used to test the stability of the solution under uncertainty or to find the optimal tariff structure. Here, the example of optimizing the tariff level is shown in Figure 3.6 and Figure 3.7. Figure 3.6 shows the demand function of ships which transit through the Canal which is the key to the revenue function. Figure 3.7 is the revenue function which shows how the revenue changes with respect to the tariff level. This function gives the optimal tariff level that gives the highest revenue.

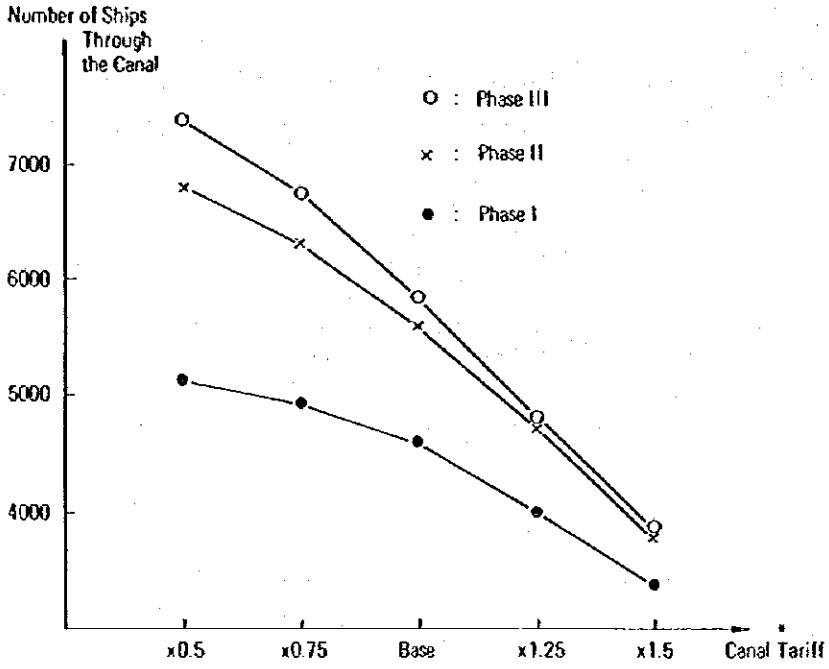


Fig. 3.6 Demand Function

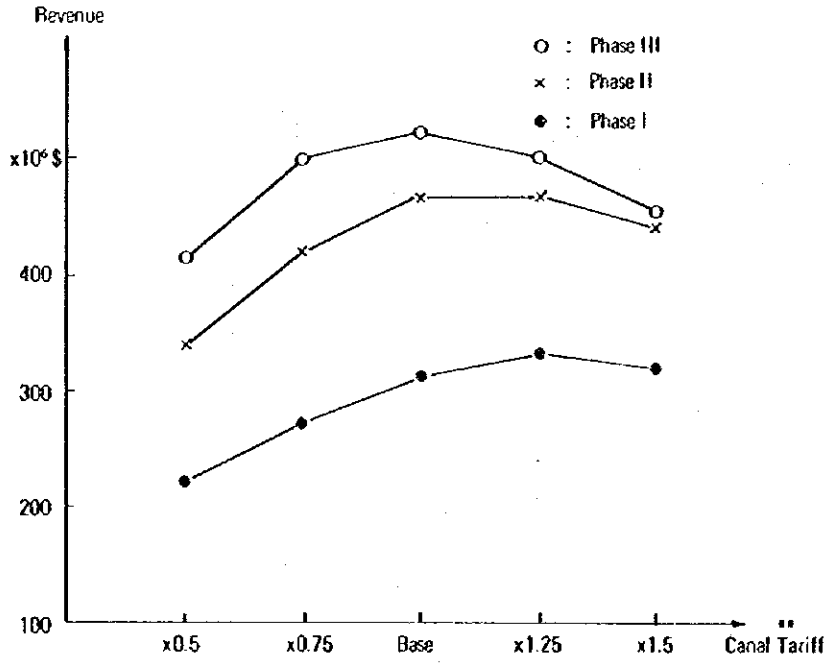


Fig. 3.7 Revenue Function

*, ** Note: Horizontal axis represents levels of the Canal tariff as differences from the "base tariff" which was explained in the lecture textbook.

3.7 Exercise

1. List up all the names of Tables shown in section 3.5 and distinguish the Table of external (given) data from those of calculation Results.

(Example)

Table List

Table 1. Development Phases and Maximum Capable Size of Ship	External Data

2. Draw a shcematic diagram of traffic forecasting by using the names of Tables listed above.

3. Assume that the external data in section 3.5 is changed as shown below (1)-(3). Forecast and make all the necessary Tables according to the schematic diagram.

(1) Fleet Structure

Size	0 ~ 60	60 ~ 150	150 ~ 200	200 ~ 260	260 ~ 330	330 ~ 700	Total
DWT (000 DWT)	10	15	15	25	20	15	100

(2) Canal Dues per Tanker Transit

(Unit: $/Trip)

Size (000 DWT)	Representing Size (DWT)	#2 S.N.T.	Due#1/Transit	
			Laden	in Ballast
0 – 60	40,000	19,624	45,037	36,035
60 – 150	105,000	53,026	121,695	97,369
150 – 200	175,000	89,742	205,958	164,789
200 – 260	230,000	128,068	293,916	235,165
260 – 330	295,000	153,668	352,667	282,173
330 –	500,000	264,778	607,665	486,199

#1 Due = 2.014 SDR (2.295#3 $) x S.N.T. (Laden)
1.611 SDR (1.836 $) x S.N.T. (in Ballast)

#2 S.C.N.R.T. = 0.357 (D.W.T.)$^{1.03}$

#3 based on the exchange ratio at January 1, 1977.

(3) Canal Charges per Ton of Cargo

Laden: 2.5 $/Ton, Ballast : 1.25 $/Ton

4. Describe the impact on transit volume and revenue derived from the changes mentioned above.

CHAPTER 4 EVALUATION OF CANAL CAPACITY

4.1 Introduction

Canal capacity is determined by the type of layout of the Canal, the method of operation and other factors. The number of ships which transit the Canal in a given period cannot exceed the capacity.

If a number of transits exceeds the capacity, a delay and/or extension of transit time occurs, which cannot be accepted by ship operators. Furthermore demand may fall. This will have a detrimental effect on the revenue of the SCA.

On the other hand, if the capacity of the Canal were much larger than the demand, the utilization of the Canal would be low and this would have an undesirable effect on the management of the SCA too.

Therefore it is very important to properly evaluate Canal capacity and to correctly assess the time schedule of the Canal expansion schemes.

The Capacity of the Canal is determined by physical layout, cross section of the Canal, method of operation, and other factors.

In the following section, methodology for evaluating the average serviceable demand is given, based on assumptions of the layout plan and manner in which the Canal is to be operated.

4.2 Capacity of the Canal

The capacity of the Canal can be measured by the number of ships or total tonnage that is able to transit the Canal in a given period. The number of ships is probably an easier measure to adopt, but the total tonnage is more closely related to the revenue of the Canal. In this Chapter, we measure Canal capacity by the maximum number of transits in a given period of time.

The capacity of the Canal depends upon the following factors:

1) the physical layout of the Canal (development schemes)
2) the manner in which the Canal is operated
3) the transit rules

To compare the effects of development schemes with each other which involve the different types and sizes of vessels, the idea of standard ships is introduced. The standard ship transits the Canal at a constant speed of 14 km/h and each ship is separated from the next by an interval of 10 minutes.

4.3 Comparative Capacity Analysis

The capacities of four stages of by-pass construction (development schemes) are determined by diagram analysis and the results are given in Table 4.1. The corresponding by-pass layouts are illustrated in Figure 4.1.

Table 4.1 Table 4.1 Theoretical Capacity of By-pass Development Schemes

Configuration		Theoretical Capacity* Standard ship transits per 24 hours
A)	Basic layout (3 convoy system)	78
B)	Addition of by-passes at Port Fouad and Deversoir	88
C)	Addition of by-pass to Lake Timsah linked with the Deversoir by-pass	100
D)	Addition of dual by-pass from Ballah to Geniefa	112
E)	Completely duplicated Canal	288

* Based on: 1) 24-hour cycle of operation
2) Equal number of standard ship transits in each direction

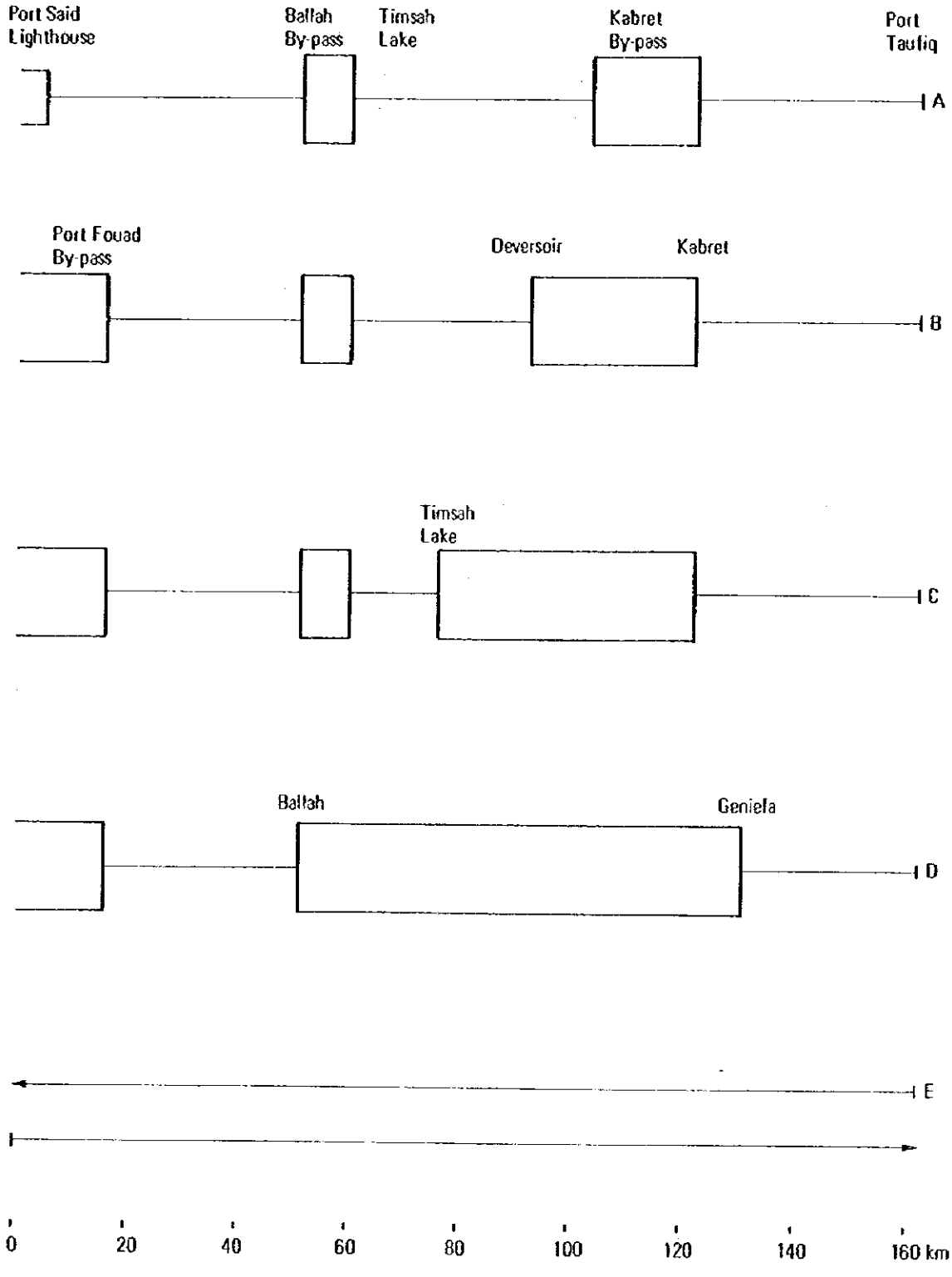


Fig. 4.1 Layouts for the Canal (Basic and By-pass Development)

4.4 Consideration of Problems Affecting the Canal Capacity

(1) Randomness of Ship Arrival

In the previous section a brief explanation was given of the concept of "theoretical capacity" of the Canal which is determined on the basis of the standard ship. However, it must be noted that the theoretical capacity of the Canal does not necessarily correspond to the actual capacity of the Canal, for in actuality the number of ships transiting the Canal may vary from day to day due to a variety of reasons that cannot be predicted and controlled.

This fact will be understood from the following example. Suppose that the number of the ships that transit the Canal in a given year is 36,500 then the average number of ships transiting the Canal per day is 100. However, it will be realised that there is a certain range of variability in the number of ships which transit during the year; 120 ships on certain days, 80 ships on other days, etc. One can easily assume from the average value (100) that during a period of half a year (183 days) more than 100 ships might pass through the Canal and for the remaining half of the year less than 100 ships might transit the Canal (see Figure 4.2).

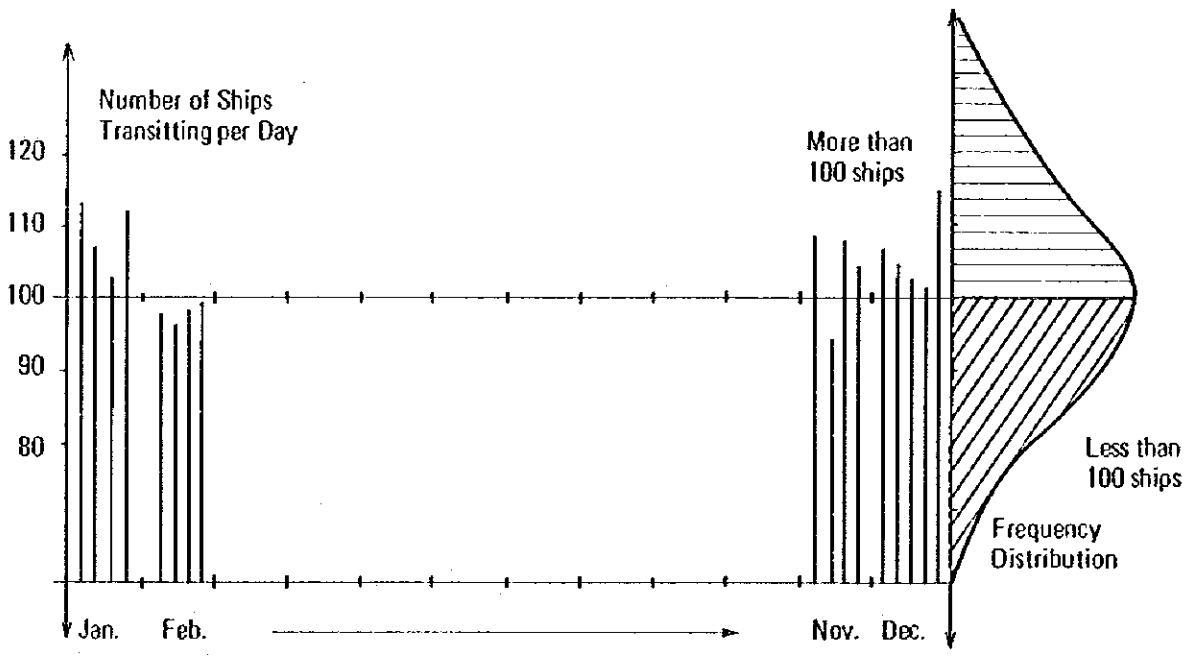


Fig. 4.2 Frequency Distribution of the Number of Ships Transiting the Canal per Day

In this example the Canal capacity could be assessed as 100 ships per day, but it could occur that many ships may wait or be delayed for a half year and the Canal would be under-utilized for the remaining half year. This situation is obviously not desirable for both the SCA and ship operators. Based on this observation it can be said that to secure a good service level for the Canal the theoretical capacity of the Canal should be set at a different level than 100 ships per day. If the theoretical capacity cannot be changed from 100 ships per day, then the average number of ships arriving at the Canal per day must be kept at a level below 100, -- say 80 ships a day, in order to avoid overcongestion of the Canal.
From this example it can easily be understood that daily variations in the number of arriving ships must be carefully analyzed in order to evaluate Canal capacity.

It could be assumed from empirical observations that the frequency distribution of arriving patterns of ships could be approximated by Poisson distribution. The statistical properties of Poisson distributions are briefly described in the following:

(1) Stationarity
The probability that k ships arrive in the duration from a to $a+t$ does not depend upon a.

(2) Absence of after-effects
The probability mentioned above does not depend upon the number of ships that arrived before a.

(3) Orderliness
The probability that more than one ship will arrive at one time is extremely small.

(4) The probability that k ships arrive in a duration t (e.g. 24 hours) is:

$$P(X=k) = \frac{\exp(-\lambda t)\,(\lambda t)^k}{k!} \quad (k=0, 1, 2, \ldots) \qquad (4\text{-}1)$$

where, X is a random variable which denotes the number of ships arriving in a duration t.

$1/\lambda$ is the average interval of successive arrivals.

(5) The average number of arrivals is λt and the variance of this is also λt.

(6) When λt is large enough (over 30), the Poisson distribution can be well approximated by the Normal distribution with same values of average and variance as the Poisson distribution.

Based upon the assumptions of the statistical properties of the Poisson distribution, the pattern of arrival of ships can be mathematically expressed by equation (4-2) which defines the relations of the following three variables:

(1) Average arriving number of ships per day which wish to transit the Canal (Naa)

(2) The probability (β) that the number of ships wishing to transit the Canal on a particular day may exceed the level specified (Nae).

$$Nae = Naa + \alpha\sqrt{Naa} \quad \text{----------(4-2)}$$

where α has a value such that equation (4-3) holds true.

$$\frac{1}{\sqrt{2\pi}} \int_{\alpha}^{\infty} \exp\left(-\frac{x^2}{2}\right) dx = \beta/100 \quad \text{----------(4-3)}$$

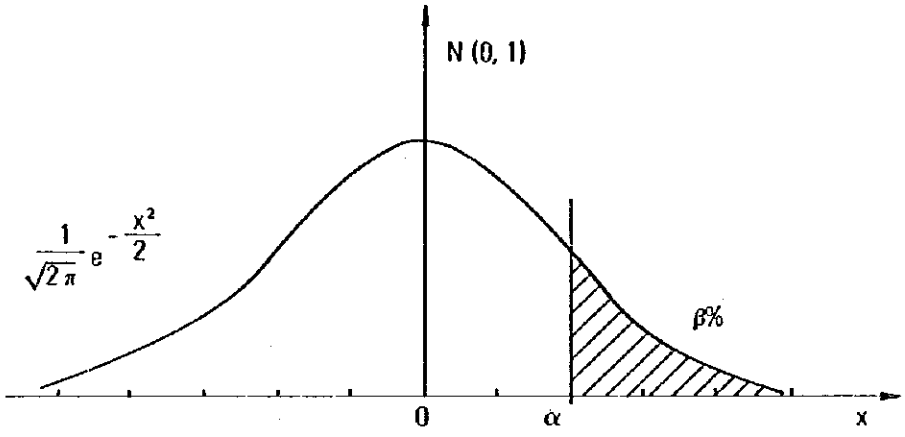


Fig. 4.3 Relationship between α and β

If the average number of arriving ships (Naa) is 100 and the probability β is 10%, then

$$Nae = 100 + 1.285 \times 10 = 112.85 = 113 \text{ --- (4-4)}$$

The equation (4-4) states that:

(1) If the average number of ships wishing to transit the Canal per day is 100, then

(2) the probability that more than 113 ships wish to transit the Canal on a day is 10% of the days of a year (37 days).

(3) Conversely if more than 113 ships wish to transit the Canal for 37 days a year, then the average number of arriving ships is 100 ships per day.

Equation (4-4) could also be interpreted as follows:

(1) If the theoretical capacity of the Canal is 113 ships per day and an average demand for Canal use is 100 ships per day, then the probability that the frequency of transit demand exceeding the Canal capacity will be estimated to be only 37 days (10%) a year.

(2) When the average number of ships wishing to transit the Canal is 100, the theoretical capacity of the Canal must be set at a level of 113 ships a day in order to maintain a probability that demand will exceed capacity at less than 10%.

The relationship between β and α is shown in Table 4.2

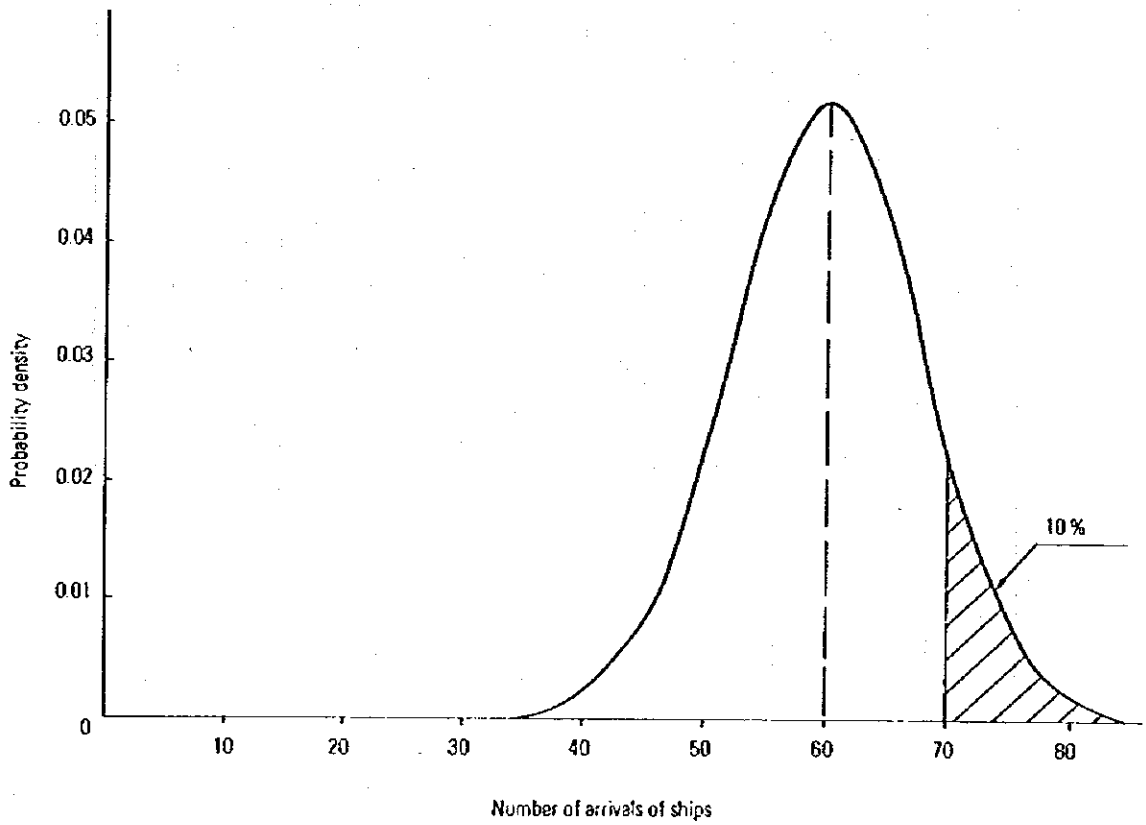
Table 4.2 Relationship Between β and α

β	α
10%	1.282
5%	1.645
2%	2.054
1%	2.326

Other numerical examples that can be derived from equation (4-2) are listed in Table 4.3. The figures in the Table should be interpreted in the following way. If, for example, the average number of ships wishing to transit the Canal is 60 ships per day, then 70 ships or more will transit the Canal for 10% of the days of a year, 73 ships or more for 5% of the days of a year and 76 ships or more for 2% of the days of a year (see Figure 4.4).

Table 4.3 Frequency of Ship Arrivals Exceeding the Average

Average number of ships wishing to transit the Canal (Naa)		For β% days a year, the number of arriving ships may exceed the figures given below (Nae)		
Per 24 hours	Per year	β = 10%	β = 5%	β = 2%
40	14,600	48	50	53
50	18,250	59	62	65
60	21,900	70	73	76
70	25,550	81	84	87
80	29,200	91	95	98
90	32,850	102	106	109
100	36,500	113	116	121
110	40,150	123	127	132



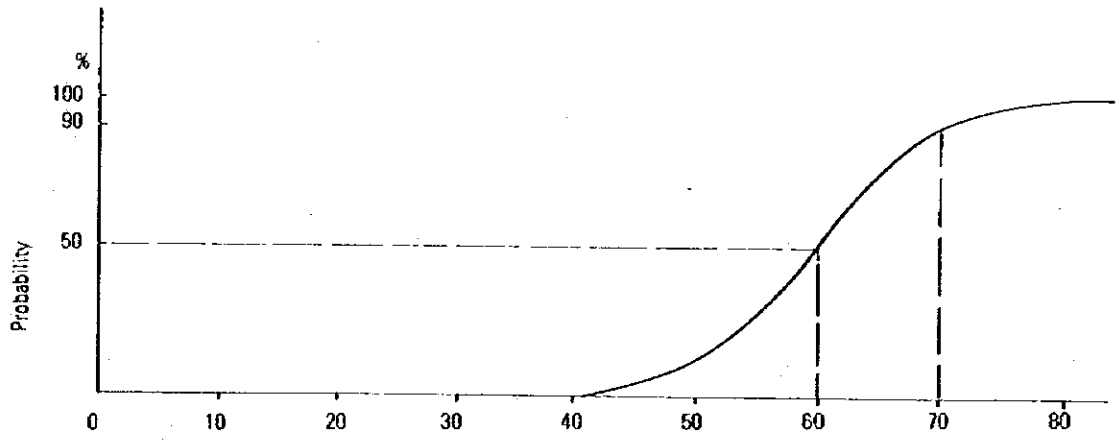


Fig. 4.4 Distribution of Number of Arriving Ships

(2) The Average Serviceable Demand (ASD)

The average serviceable demand is a concept which indicates the amount of ships transit demand that will be met by the Canal capacity at normal operating conditions. The level of the ASD will be determined by the following three factors:

1) Tolerance time at by-passes; the time interval that must be allowed between the time when the last ship of a northbound convoy passes the entrance of the by-pass and the time when the first ship of a southbound convoy leaves the by-pass. The total theoretical capacity of the Canal will be reduced by about 3% by this time allowance in the case of the basic layout (see Figure 4.1).

2) Randomness of arriving pattern of the ships wishing to transit the Canal: this factor has already been explained in the previous section.

3) The Canal capacity reduction that could be caused by randomness of transiting speed of ships and by other unexpected factors.

The ASD for the three convoy systems for the basic layout A can be calculated as follows:

1) Canal capacity reduction from the consideration of tolerance time allowance (X_1):

   X_1 = theoretical capacity (78 ships/24 hours) x 97%

   = 75.7 ships

2) Canal capacity after taking into account randomness (X_2):

   $X_2 = X_1 - 1.282 \times \sqrt{X_1} = 64.5$ ships

3) Canal capacity of the ASD after taking into consideration other factors:

   The ASD = X_2 x 95% = 61.3 = 61 ships/24 hours

   (A 5% reduction factor is assumed for all other effects).

4.5 Exercises

Problem 1.

List the ways by which the capacity of the Canal can be increased.

Problem 2.

Draw a transit diagram for the following conditions.

(1) Layout (plan B)

Port Fouad by-pass (0-16 km) and Deversoir by-pass are to be added to the basic layout.

(2) Convoy system

In a three convoy system, one passes northbound without stopping and the others are southbound waiting in the by-passes.

(3) Standard ship

Navigating speed	14 km/h
Separation distance	10 minutes

(4) Operating cycle time 24 hours

(5) The proportion of the northbound transits is 60%.

(6) Operation is at the maximum capacity.

Problem 3.

Capacity Analysis

(1) What is the theoretical capacity of layout plan B?

(2) What is the average Serviceable Demand of layout plan B when β=10% and 5%?

(3) Compare the capacity of the present layout with that of layout B and E.

Layout	Total Length of the By-passes (km)	The Theoratical Capacity (Ships/24h)	The Average Serviceable Demand (β = 10%)
A	(100)	(100)	(100)
B			
E			

CHAPTER 5 PROJECT EVALUATION

5.1 Introduction

5.1.1 Objective of Feasibility Study

The concept of "feasibility study" is not yet clearly established. However, a feasibility study can be simply defined as a study which assists in answering the question of whether or not a project should be carried out, judged mainly from the viewpoint of national economy.

This question must be asked because; (1) a government and/or other public authorities must have the information relevant to the decision to be made on whether or not a project is beneficial, and on which of the projects should be carried out if there have been several alternative projects conceived concerning the timing, size of location, method of construction, and so on; (2) international financial organizations, such as the World Bank, needs to know whether a project qualifies for a loan and or financial aid.

In the case of the Second Stage of Suez Canal Development, the latter point should be judged more important than the former, because to meet the criteria of the World Bank for financial aid is a prerequisite for the implementation of the Development plan. Hence, the remainder of this Chapter will focus upon the method of project evaluation, mainly taking into account the World Bank criteria.

5.1.2 Aspects of Project Evaluation

As mentioned in Chapter 1, the feasibility study on the Suez Canal Development Project has three phases of procedure which are:

1) Determining the various expansion schemes for the Suez Canal,
2) Forecasting Canal traffic,
3) Project evaluation.

Of these three, this Chapter focuses on project evaluation (or project appraisal). Project evaluation mainly covers six aspects of the project; i. e., the technical, economic, commercial, financial, managerial and organizational aspects. Technical evaluation examines all the features of the project design, the cost estimates and construction schedule.

Economic evaluation is the same as "Cost Benefit Analysis" which is concerned with the economic effectiveness of the project judged from the viewpoints of both national and world economies as a whole. Commercial considerations cover all the arrangements for buying-input and selling-output of the project including an evaluation of market demand for project output. The Canal transit fleet mix and related revenue will be subject to commercial evaluation in the case of the Suez Canal Development Projects. The financial aspect, which is closely related to the commercial, focuses on two issues. The first is whether or not sufficient funds are available, and the second is whether the eneterprise (SCA) will able to meet all its financial obligations. The managerial aspect deals with the adequacy of the top management to direct the construction and operation of the project. The organization aspect is concerned with the administrative structure of the enterprise carrying out the project.

Among the six aspects of evaluation mentioned above, only three, viz.; economic, commercial and financial, are treated in this Chapter. However, the latter two are so closely related to each other, that they are jointly considered under financial evaluation in this Chapter.

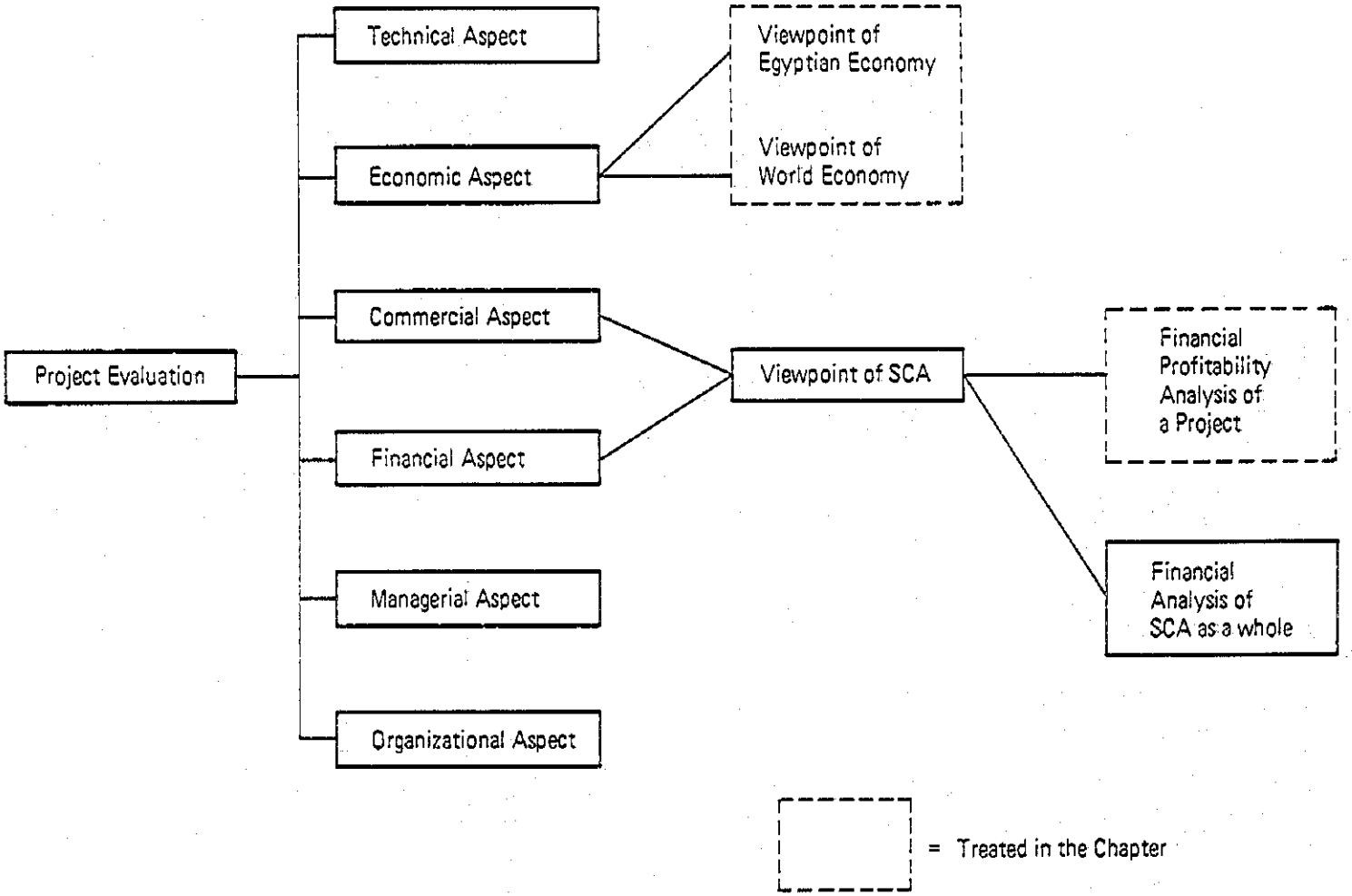


Fig. 5.1 Aspects of Project Evaluation

5.1.3 Definition

(1) Project

A project is a set of minimum activities which are economically and technically feasible in themselves to achieve its objectives.
Examples of such projects concerning SCA are as follows:

1) Expansion of Canal Cross Section
2) Improvement of Convoy System
3) Change of Tariff Structure
4) Construction of Houses
5) Improvement of Port Facilities
6) Expansion of Shipyards
7) Installation of Weather Forecasting Facilities, etc.

(2) Economic Appraisal

Economic appraisal is a process through which the economic costs and benefits of a project are measured from the viewpoints of a country and/or the world as a whole. In order to determine whether net benefits are at least as great as those obtainable from other investment opportunities, costs and benefits are to be evaluated in terms of the willingness-to-pay of the demand sector which would buy the resources, products and/or services.

In the case of SCA, economic appraisal can be made from two points of view: the Egyptian Economy and the World Economy.

(3) Financial Evaluation

Financial evaluation is divided into two types. The first can be said to be the financial (or commercial) profitability analysis of a project, and the other the management accounting of the enterprise as a whole. The former is primarily concerned with a project's profitability, while the latter aims at evaluating an enterprise's finance as a whole by means of balance sheet and income and expenditure account analysis.

This chapter deals only with the project's financial profitability analysis. Hence in this chapter the term, "financial evaluation", implies only the financial profitability analysis of the project.

In this sense the term, "financila evaluation" can be defined as the measurement of the financial costs and revenues of a project in respect of an individual financial entity such as SCA. That is, in order to determine whether a project's net profit (or the return on the equity capital) is at least as great as that obtainable from other marginal investment opportunities, the costs and revenue are evaluated based on the market price.

5.2 Comparison between Economic and Financial Evaluation

5.2.1 Economic vs. Financial Evaluation

Table 5-1 summarizes the differences between economic and financial evaluations. Then six major features are listed below. The first three points are common to both and the remaining three are peculiar to each.

(1) Both evaluations are based on a "With and Without Comparison" instead of a "Before and After Comparison".

(2) Both evaluations adopt the discounted cash flow analysis which is the method of comparison of time streams of benefits (revenues) and costs.

(3) Depreciation should be neither included nor counted in any case of evaluation. Because the invested capital is already accounted for in capital costs, the inclusion of depreciation would constitute double counting.

(4) When the input and output of a project are translated into monetary terms, in the case of financial evaluation the dominant market prices are always used. Conversely, in the case of economic evaluation, since the market prices do not necessarily reflect the real scarcity of the resources, the shadow prices (or accounting prices) are used instead of market prices.

(5) Because subsidies and tax are purely transfer payments, in the case of economic evaluation these two items should not be included. However, in the case of financial analysis, both the subsidies and tax which the associated entity (SCA) has to pay or can obtain, should be included as revenue (for subsidies) and costs (for tax), respectively.

(6) Payment of interest should also be excluded from the economic evaluation because it is a form of pure transferred payment out of the real net benefits of the project. On the other hand in the financial analysis the interest paid by the associated entity (SCA) to an outside organization should be counted as a kind of cost.

Table 5.1 Economic and Financial Evaluation

	Economic Evaluation		Financial Evaluation
	Egyptian Economy	World Economy	SCA
Benfits and Revenue	(1) Toll Revenue (2) Cost reduction for Egyptian ships (3) Others	(1) Toll Revenue (= Producers' Benefit) (2) Cost reduction for shipping (= Users' Benift) (3) Others	(1) Toll Revenue
			Subsidies from outside SCA
Costs	(1) Capital Costs (2) Operating and Maintenance Costs	(2) Capital Costs (3) Operating and Maintenance Costs	(1) SCA's Equity of Capital Cost (2) SCA's Equity of Operating and Maintenance Costs
			(3) Payment of Interest (4) Payment of Tax (5) Payment of Royalities
Externalities	(1) Changes of Pipeline Revenues (2) Others	(1) Changes of Pipeline Revenues (2) Others	
Rank of importance in the evaluation of the World Bank	1	3	2
Note	(1) Subsidies, tax, and payment of interest should not be included. (2) Use the shadow prices (accounting prices) if necessary.		(1) They should be included. (2) Use the market prices.
	Both use Discounted Cash Flow Analysis based on the "With and Without Comparison".		

5.2.2 Use of Shadow or Accounting Prices

Shadow or accounting prices are used only in the economic analysis, not in the financial analysis. A shadow price is the value which would reflect real economic scarcities, or it may be defined as the price which would prevail in the economy if it were at perfect equilibrium under conditions of perfect competition. Although the definition of shadow price is very difficult and the definition given above is imcomplete, in the actual work of economic evaluation the shadow prices may be used although limited to the following two cases:

1) Foreign Exchange Rate
2) Labor

(1) Foreign Exchange Rate

Egypt has two kinds of foreign exchange rate, the official rate and the tourist rate. However, neither the official rate nor the tourist rate would be correct if it were used in the economic evaluation. True economic scarcity is reflected in the world foreign exchange market. Hence in the economic evaluation the imported materials and toll revenues should be evaluated using the foreign exchange rate in the world market at the given time.

(2) Wages

If Egypt has considerable unemployment, it will be regarded as reasonable to price labor at a level below actual wage levels if the project is to employ labor from those who are unemployed.

5.3 Economic Evaluation

5.3.1 Identifying Costs and Benefits

The most important means of identifying the costs and benefits of a given project is to make the "With and Without Comparison". This makes it which is possible to determine the differences between the situation with and the situation without the project, instead of considering the differences before and after the project is carried out.

Table 5.2 shows examples of costs and benefits which could be derived from the projects which SCA may execute at present and/or in the future.

In the case of those projects such as expansion of cross section, improvement of convoy system and/or changes in the tariff structure, the most important benefits would be the increase in SCA revenues, and cost reduction of shipping. On the cost side, however, the situation varies with the projects. In the case of changes in the tariff structure the capital cost is hardly needed, by contrast, those projects which need considerable civil works such as expansion of cross section, improvement of convoy system and so on, incur very high capital costs.

Table 5.2 Examples of Costs and Benefits

	Egyptian Viewpoint	World Viewpoint
Benefits	o Increase of SCA Revenues o Cost reduction for Egyptian ships o Saving of time of Egyptian ships o Fewer accidents and reduced damage concerning Egyptian ships and cargo.	o Increase of SCA Revenues o Cost reduction of shipping o Reduction of time of shipping o Fewer accidents and reduced damage
Costs	o Capital Costs Dry excavation Revetment Dredging Breakwater extention Offshore bollards Construction of berths Equipment o Additional Operating and Maintenance Costs Administration and general expenses Canal and portside working expenses Canal and portside maintenance expenses Maintenance and replacement of equipment o Other Incremental Costs Consulting and technical assistance Environmental damage costs	

5.3.2 Measuring Benefits

Among those benefits which would be derived from such projects as (a) the expansion of the canal cross section, (b) the improvement of the convoy system and (c) the change of tariff structure, the most important benefits would be:

1) Increase of toll revenues and
2) Savings in ship costs.

The former benefits the Egyptian economy, and the latter the world shipowners. From the viewpoint of the Egyptian economy the former is obviously of considerable importance but for the world economic evaluation both the former and the latter should be regarded as significant benefits. This study is mainly concerned with these two main benefits and describes methods to measure them.

Measurement of benefits can be divided into two stages; firstly the calculation of estimated annual benefits to be accrued in a given year, and secondly the production of a time-stream of benefits.

(1) Calculation of Annual Benefits

The procedure for calculation of annual benefits can be divided into three parts: (a) calculation of main Egyptian benefits, (b) calculation of Canal users' benefits, and (c) calculation of global benefits. Each of the calculation procedures is shown in Figs. 5.2 - 5.4 and explained below.

(a) Calculation Procedure for Main Egyptian Benefits

Step 1. Ascertain the Canal situation that will result from a givn project and the situation without the project in terms of

(1) Daily canal capacity
(2) Canal transit time
(3) Canal transit regulation
(4) Canal tariff structure.

Step 2. Input into the forecasting model the two sets of output values derived from Step 1, i.e., with and without the project.

Step 3. Forecast two sets of values of annual Canal traffic volume, for with and without the project. The output should comprise the number of ships and of ship tonnages, and should be categorized by route, type of ship and by laden or in-ballast.

Step 4. Calculate the toll revenue for the two cases, with and without the project respectively, by multiplying each value of tariff by the corresponding Canal traffic volumes.

Step 5. Subtract from the revenue with-the-project the value without-the-project. The result gives the increase in toll revenue derived from the project, this being the Egyptian benefit from the project.

(b) Calculation Procedure for Main Canal User's Benefits

Step 1. Same as in the case of the Egyptian benefits

Step 2. Same as in the case of the Egyptian benefits

Step 3. Forecast two sets of values of annual traffic volumes for each route relevant to the Suez Canal with and without the project. The output should comprise the number of ships and of cargo tonnages, and be categorized by the kind of cargo, by the route and by the type of ship.

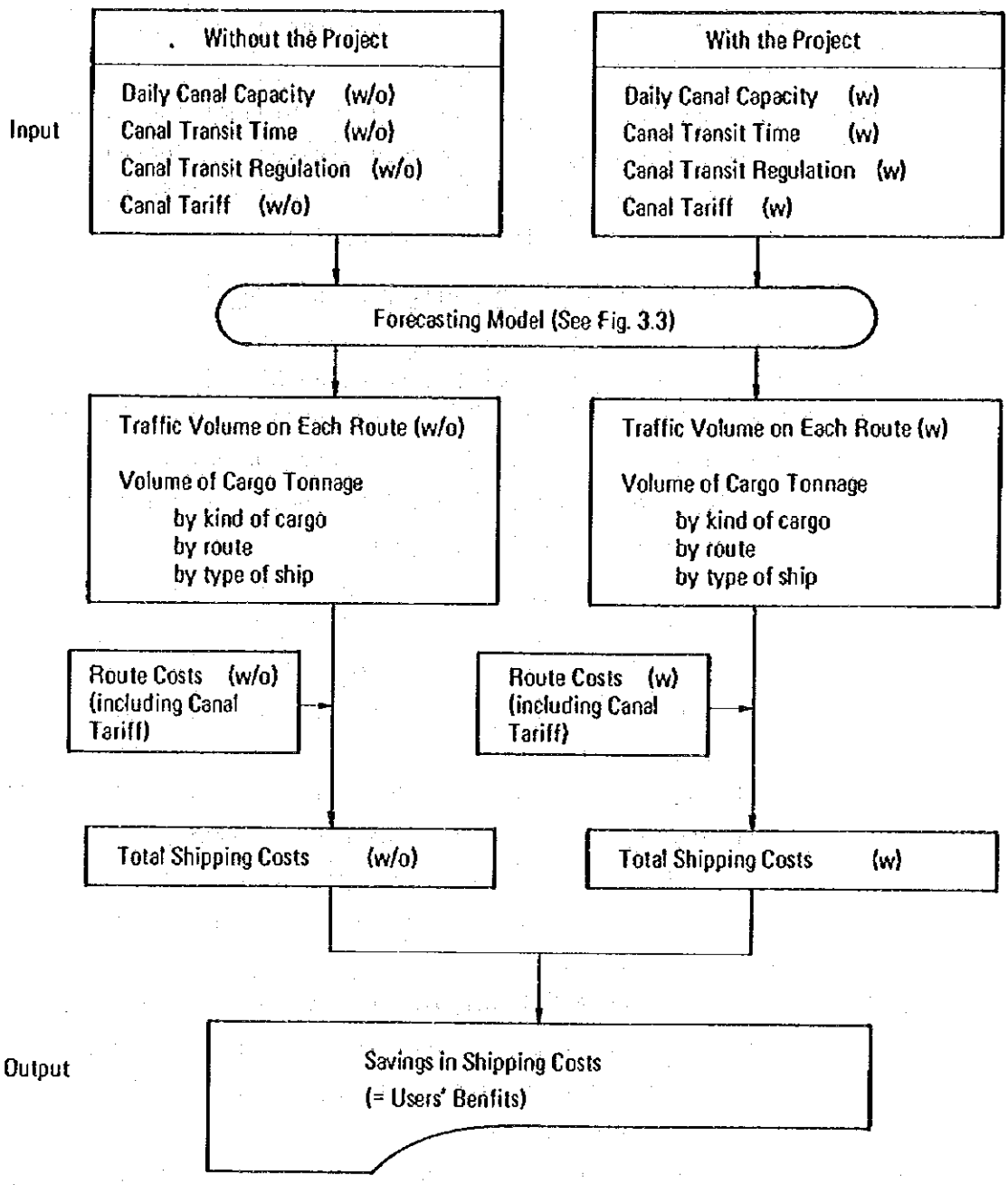
Step 4. At the same time, as Step 3, forecast two sets of values of route costs for each route relevant to the Suez Canal, with and without the project, respectively. Each route cost shall include the respective Canal tariff depending on the situation; with or without the project. The output should have the dimension of $ per cargo loaded and should be categorized as in the case of traffic volume.

Step 5. Calculate the total shipping costs for the two cases, with and without the project respectively, by multiplying each route cost by the corresponding value of annual traffic volume.

Step 6. Subtract from the total shipping costs of without-the-project the total costs of with-the-project. The result gives the saving in shipping costs, which is the users' benefit derived from the project.

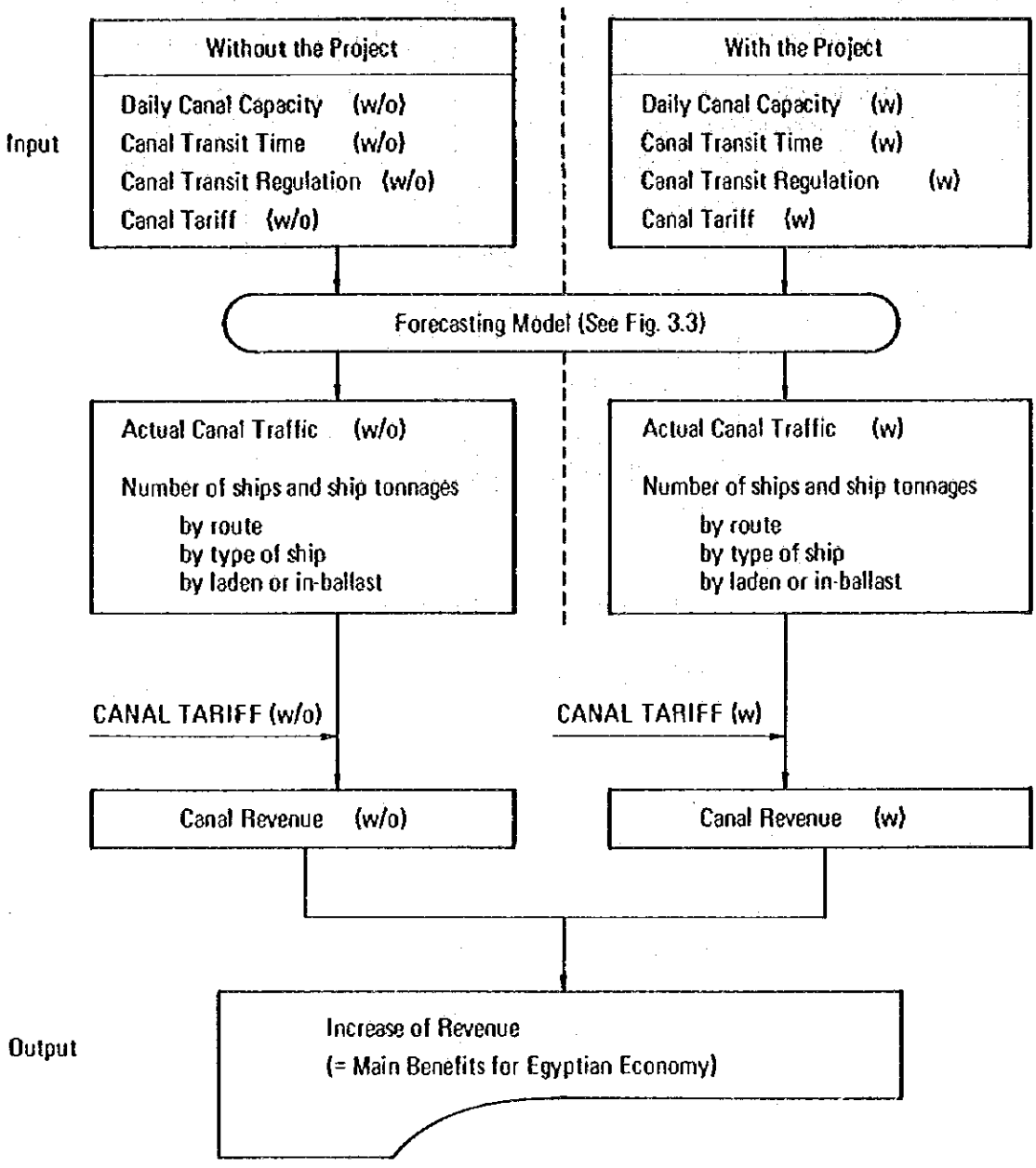
(c) Calculation of Global Benefits

Sum up the increase of toll revenues and the savings in shipping costs. The result is the global benefit which is the main benefit for the world economy.



Note: w/o = Without the project.
w = With the project.

Fig. 5.2 Calculation Procedure for Users' Benefits



Note: w/o = Without the project.
w = With the project.

Fig. 5.3 Calculation Procedure for Main Egyptian Benefits

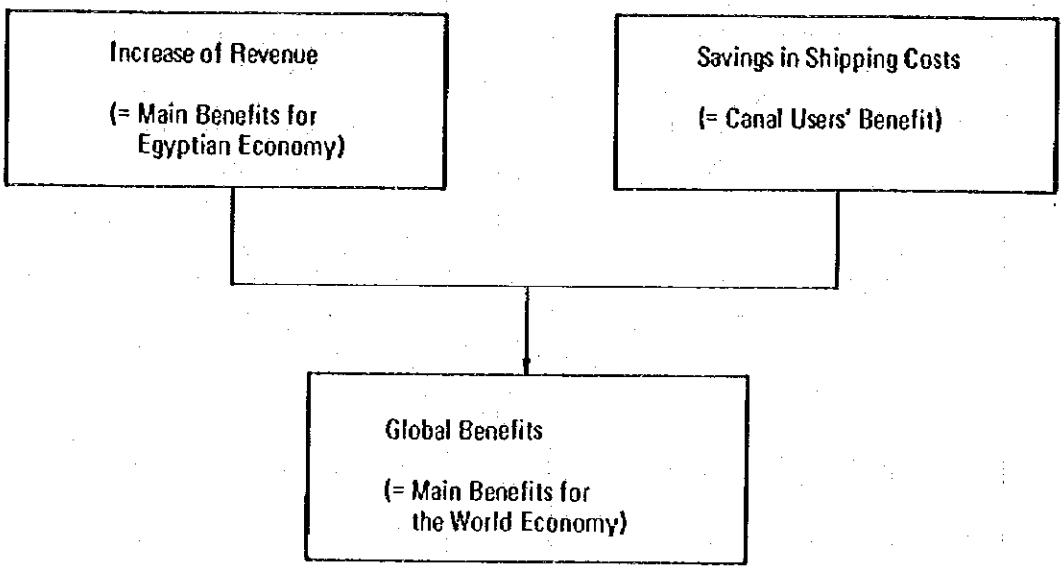
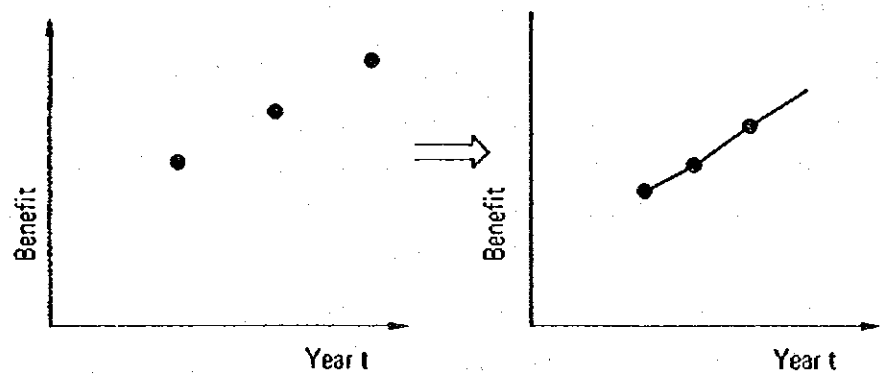


Fig. 5.4 Calculation of Global Benefits

(2) Producing a Time-stream of Benefits

There are two ways by which a time-stream of benefits could be produced;

1) Carrying out the full calculation of the annual benefits, above in (1), for every year during the project life.
2) First, carrying out a full calculation of the annual benefits for only a few important years, and then estimating benefits of each year by means of extrapolation and/or interpolation as shown below:



Note: Extrapolation and interpolation are operations of regression analysis.

The choice between the two methods depends on the conditions of the analysis. The availability of time, labor and other resources to perform the analysis constitute one set of conditions. And second give the type of analysis required by the project. This second type of determinance is exemplified by the Second Canal Development Plan. This plan has two development stages; the first stage is scheduled to end around 1980, then the second stage will start. In case of such a type of project, it is recommendable that the full calculation of benefits every year at least from 1978 to 1985 be carried out, then extrapolation may be used after 1985.

5.3.3 Estimation of Costs

Given the concrete project design, the estimation of economic costs can be made in three stages:

1) Estimation of total project costs
2) Division of total costs into the categories of foreign and local currency
3) Division of project expenditures into yearly expenditures

(= Giving a time-stream of project costs).

There are two important rules concerning the estimation of costs: firstly the "with and without comparison", and secondly consideration of the "economic evaluation".

Regarding the with-and-without comparison, the capital costs could be estimated with relative ease once the engineering specifications of the project are known. However, one must be careful in the estimation of operating and maintenance costs, since only incremental costs accrued from the project should be identified and estimated.

As to the second rule of the economic evaluation, the following must be taken into consideration; first the analyst must be careful of how tax, subsidies, the payment of interest, and depreciation are treated, as mentioned in Section 5.2; second, the shadow price of labor must be used if there is considerable unemployment; and third, the shadow value of the foreign exchange rate should be used if there is a fixed exchange rate. In the event that a shadow value of the foreign exchange rate is required the world market exchange rate should be used.

5.3.4 Comparing Costs and Benefits

(1) Kinds of Criterion Indices and Their Definitions

There are at least three criterion indices for measuring the performance level of a project:

1) Present Net Worth (PNW)
2) Internal Rate of Return (IRR)
3) Benefit Cost Ratio (B/C)

Each index can be represented by the following equations, given the time-streams of both benefits and costs, as shown in Figure 5.5.

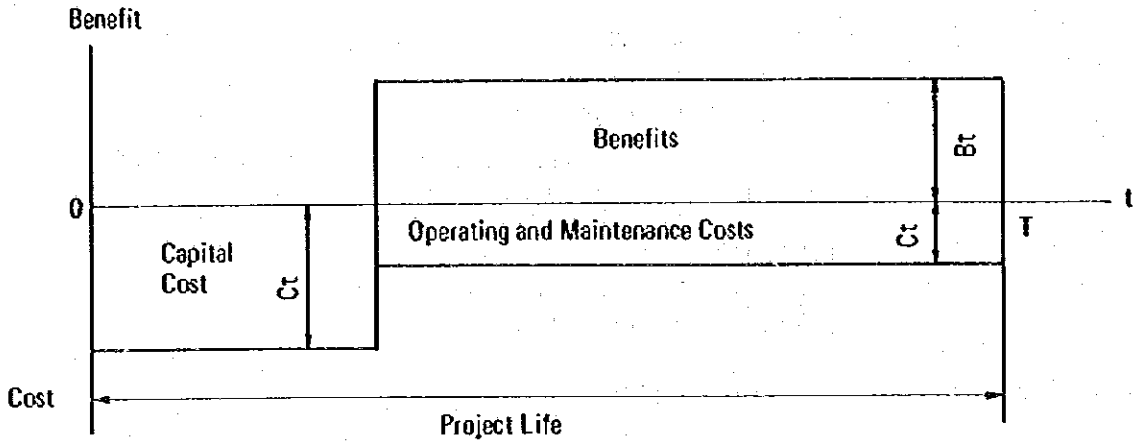


Fig. 5.5 Time-Streams of Costs and Benefits

(1) Present Net Worth (PNW)

$$PNW = \sum_{t=0}^{T} \frac{Bt-Ct}{(1+r)^t}$$

(2) Internal Rate of Return (IRR)

IRR is the value of x such that

$$\sum_{t=0}^{T} \frac{Bt}{(1+x)^t} = \sum_{t=0}^{T} \frac{Ct}{(1+x)^t}$$

(3) Benefit Cost Ratio

$$B/C = \left(\sum_{t=0}^{T} Bt/(1+r)^t \right) / \left(\sum_{t=0}^{T} Ct/(1+r)^t \right)$$

where,
- t: year
- T: project life
- r: social discount rate
- Bt: benefit in year t.
- Ct: cost in year t.

(2) How to Use the Indices for the Criterion of Project Evaluation

The way in which the three indices for the criterion of project choice can be used is as follows:

(1) Present Net Worth

If PNW > 0, the project should be recommended
If PNW < 0, the project should be rejected

(2) Internal Rate of Return

If IRR ≥ OCC, recommended
IF IRR < OCC, rejected

where the OCC is denoted by the opportunity cost of capital (usually 3-14%).

(3) Benefit Cost Ratio

If (B/C) ≥ 1, recommended
If B/C < 1, rejected

(3) Comparison of Criterion Index

Index	Merits	Demerits
PNW	The most precise	Difficult to estimate the Social Discount Rate (SDR)
IRR	The World Bank prefers Shows the efficiency of capital No need to use the value of the SDR	Difficult to estimate the OCC
B/C	Shows the efficiency of capital	Difficult to estimate the SDR

5.4 Financial Evaluation

5.4.1 Identifying Financial Costs and Revenues

As mentioned in 5.1.3, (1), financial evaluation consists of two parts; the financial (or commercial) profitability analysis of a project and the managerial accounting analysis of the enterprise as a whole.

In order to carry out the first through identification of the costs and the revenues of a project, the most important rule to be observed is use of the method of "with and without comparison" as in the economic evaluation.

Table 5.3 shows examples of financial costs and revenues which could be derived for the projects which SCA may plan at present and/or in the future.

Table 5.3 Examples of Financial Costs and Revenues

	Only SCA Viewpoint	
Revenues	o Increment of Toll Revenues o Decrease of Compensation for Accidents	
	o Subsidies from Outside of SCA	
Costs	o Capital Costs o Additional Operating and Maintenance Costs o Other Incremental Costs	
	o Taxes o Custom Duties	o Payment of Interest o Royalties

5.4.2 Measuring Revenues

Among these revenues, the most important are:

1) Increase of toll revenues, and
2) Subsidies from outside of SCA.

Calculation of the former is made, in exactly the same was as in the already explained economic evaluation except for one point. In the case of the economic evaluation, "real price" should be used, however, in the case of the financial evaluation the fixed foreign exchange rate and the inflated price should be used if they are available.

As for the calculation of the latter, the amount can easily be abstracted from the project plan. Note that in this case the market price should be used.

5.4.3 Measuring Financial Costs

In addition to the increment in capital costs and the operating and maintenance costs which are evaluated using market prices, it is necessary for the estimation of the financial costs to include tax, import duties and the payment of interest.

It must be noted that in the case of the financial evaluation the costs should be represented by the inflated prices if they obtain. It must also be noted that depreciation should be excluded from the financial evaluation, because it has already been accounted for by the increment in capital costs.

5.4.4 Comparing Costs and Revenue

The types of criterion indices and the way in which these indices are used, are exactly the same as in the economic evaluation except for two points; first, the social discount rate r should be replaced by the market interest rate and second, the opportunity cost of capital (OCC) should be substituted by the sum of the market interest rate and the inflation rate.

5.5 Exercises

(1) Project

An SCA Director has been considering a plan to deepen the Canal draught and enlarge the Canal cross-section by the end of 1980 in order to enable VLCC to pass through the Canal. The maximum size of tankers so enabled are shown in Table A.

Table A Maximum Size of Ship Capable of Transit

Development Phase	Draught (feet)	Wet Cross-section (m^2)	Maximum Size (1,000 DWT)	
			Laden	Ballast
Without project	38	1,800	60	200
With project	53	3,600	150	330

(2) Cost Estimation

In order to provide the information necessary for decision making concerning whether or not this plan has good economic and financial justification, the director first, estimated the costs for this project assuming a project life of 14 years starting from 1977. The total cost and schedule of construction of the project is shown in Table B.

In the process of cost estimation, the import duty which was estimated as 10% of the capital cost per each year was included, because this project would require the importation of very expensive foreign materials. And although the costs shown in Table B use the real price as of January 1st 1977, it was assumed that inflation would affect the operating and maintenance costs after 1980 and their rate was estimated as 3%.

Table B Cost Estimation

(Unit: Million $)

Year	Capital Cost	Incremental O & M Costs
1977	200	
1978	200	
1979	200	
1980	200	
1981		5
⋮	⋮	⋮
1990		5
Total	800	50
	850	

(3) Transit Forecast

Next, the director making the cost estimation decided to forecast the transit volume for 1981. In order to do so, he made the following assumptions which seemed to be reasonable:

1) There were only three pairs of relevant trade flows from A.G. (Arabian Gulf) to N.E. (North Europe), from A.G. to M.S. (Mediterranean Sea) and from A.G. to U.S.A.
2) The commodity that had to be studied was of only one kind, i.e. crude oil, which meant that only tanker transits would need to be analyzed.
3) Each volume of the trade flow were obtained from by the forecast for the world economy and seaborne trade.
4) The fleet mix on the routes relevant to the Canal was roughly a reflection of the actual world fleet mix.

Based on the assumptions mentioned above, the forecast of the various results of the transit volume for this project was made.

(4) Revenue Forecast

Next, the director forecast the toll revenue for 1981. The results are shown in Table C.

Table C Revenues by Ships Through the Canal

(Unit: 1,000$)

	Ship Size (1,000 DWT)	North Bound	South Bound	Total
Without project	0 – 60	70559.	56455.	127014.
	60 – 150	0.	85231.	85231.
	150 – 200	0.	35406.	35406.
	200 – 260	0.	0.	0.
	260 – 330	0.	0.	0.
	330 – 700	0.	0.	0.
	Total	70559.	177092.	247651.
With project	0 – 60	70559.	56455.	127014.
	60 – 150	11332.	35231.	96563.
	150 – 200	0.	35406.	35406.
	200 – 260	0.	93975.	93975.
	260 – 330	0.	61217.	61217.
	330 – 700	0.	0.	0.
	Total	81891.	332284.	414175.

(5) Calculation of Annual Benefits

Because the director was very busy, he asked the Economic Unit to carry out the calculation of annual benefits and the remaining work of project evaluation, giving only the data shown in Tables D and E.

Table D Transit Volume for Each Route

(Unit: Million mt/year)

	Size of Ships (1000 DWT)	S/S		C/S		C/C	
		W/O	W	W/O	W	W/O	W
A.G. – N.E.	0 – 60	46.5	46.5	0.0	0.0	0.0	0.0
	60 – 150	0.0	0.0	68.2	68.2	0.0	0.0
	150 – 200	0.0	0.0	27.9	27.9	0.0	0.0
	200 – 260	0.0	0.0	0.0	68.2	68.2	0.0
	260 – 330	0.0	0.0	0.0	62.0	62.0	0.0
	330 – 700	0.0	0.0	0.0	0.0	37.2	37.2
	Total	46.5	46.5	96.1	226.3	167.4	37.2
A.G. – M.	0 – 60	7.5	7.5	0.0	0.0	0.0	0.0
	60 – 150	0.0	11.0	11.0	0.0	0.0	0.0
	150 – 200	0.0	0.0	4.5	4.5	0.0	0.0
	200 – 260	0.0	0.0	0.0	11.0	11.0	0.0
	260 – 330	0.0	0.0	0.0	10.0	10.0	0.0
	330 – 700	0.0	0.0	0.0	0.0	6.0	6.0
	Total	7.5	18.5	15.5	25.5	27.0	6.0
A.G. – U.S.	0 – 60	16.5	16.5	0.0	0.0	0.0	0.0
	60 – 150	0.0	0.0	24.2	24.2	0.0	0.0
	150 – 200	0.0	0.0	9.9	9.9	0.0	0.0
	200 – 260	0.0	0.0	0.0	24.2	24.2	0.0
	260 – 330	0.0	0.0	0.0	0.0	22.0	22.0
	330 – 700	0.0	0.0	0.0	0.0	13.2	13.2
	Total	16.5	16.5	34.1	58.3	59.4	35.2

Note: W/O: Without project
W: With project

Table E Cost of Shipping per Ton of Cargo by Route

(Unit: $/Ton)

O–D	A.G. – N. Europe			A.G. – E. Mediterranean			A.G. – U.S.A.		
Route / Ship Size (1,000 DWT)	Via Cape	Via Suez		Via Capa	Via Suez		Via Capa	Via Suez	
		Laden	Ballast		Laden	Ballast		Laden	Ballast
Distance (km)	11.203	6.560		11.069	4.705		12.039	8.668	
0 – 60	7.99	7.21	6.21	7.91	6.09	5.09	8.49	8.47	7.47
60 – 150	5.18	5.32	4.32	5.13	4.58	3.58	5.52	6.17	5.17
150 – 200	4.42	4.84	3.84	4.37	4.21	3.21	4.70	5.56	4.56
200 – 260	3.94	4.55	3.55	3.90	3.99	2.99	4.19	5.18	4.18
260 – 330	3.59	4.34	3.34	3.56	3.84	2.84	3.82	4.91	3.91
330 –	2.52	3.68	2.68	2.49	3.35	2.35	2.67	4.06	3.06

Notes: (1) Including canal dues
(2) Oneway cost ($/Ton)

(6) Problem

The staff of the Economic Unit decided to complete the project evaluation. In order to do so, they set themselves the following tasks:

1) Cost Estimation

(i) Make two kinds of time-streams, i.e. economic and financial cost streams,

(ii) Calculate the economic and financial present values of costs for this project, taking the following assumptions:

- 10% of the capital cost shown in Table B is import duties.
- The inflation rate of operating and maintenance costs after 1980 will be 3%.
- The social discount rate is 12%.

2) Annual Revenues and Benefits for 1981

(i) Calculate the annual benefit for 1981 from the viewpoint of the Egyptian Economy

(ii) Calculate the annual benefit for 1981 from the viewpoint of the World Economy

(iii) Calculate the SCA's net revenue after tax taking the following assumptions:

- The proportion of Egyptian shipowners who will benefit from the ship cost savings due to the project is expected to be 10% of total savings of world transportation costs.
- SCA will have to pay to the government income tax equivalent to 40% of its revenues.

3) Benefit Evaluation

The evaluation was decided to be undertaken from three points of view, i.e., the Egyptian Economy, the World Economy, and SCA,

(i) Derive the time-streams for the three kinds of benefits for this project

(ii) Calculate the present value of the three kinds of benefits for the project, taking the following assumptions:

- the social discount rate is 12%,
- the market interest rate is 10%,
- the growth rate of revenues and benefits in real terms is 5%,
- the project life is 14 years starting from 1977,

- there is no inflation affecting relevant items of benefit,
- the foreign exchange rate will not change during the project life.

4) Calculation of PNW, B/C, IRR

Calculate PNW, B/C, and IRR for this project from the three points of view given in (C).

5) Discussion

Suppose that the opportunity cost of capital is 12% and that the market interest rate is 10%, what can be said about the merits and demerits of this project?

SPECIAL LECTURE - A REVIEW OF FORECASTING METHODS

1. Introduction

The Economic Unit of the SCA is expected to perform, as an important part of its functions, Canal traffic analysis and short-term transit forecasting. The staff members of the Economic Unit are required to have a basic knowledge of the methods of analysis and forecasting.

The knowledge needed for this work extends over a wide range of fields because the traffic of the Canal (ships/goods) is dependent on world trade that is influenced by natural, economic, political, social and other conditions world-wide. (Ref. to Figure 1.1, Chapter 1, PART II, No. 3).

Another kind of the knowledge necessary for this work is related to the mathematical tools required for analysis and forecasting. The staff members have to aquire these basic tools together with the concept of systems analysis. For further information on system analysis, see "Systems Analysis" prepared and lectured by Prof. Yoshikawa of Kyoto University; the concepts of alternatives, assumptions, criteria and risk were explained.

In the present review we are concerned only with some of the mathematical methods which are commonly used for analysis and forecasting. In the following curve fitting, time series analysis and route choice are briefly described.

2. Curve Fitting

It may be recalled that the method of least squares was applied to various problems, for example, energy consumption v.s. GDP, development of oil production in several areas of the world, development of world international seaborne trade and so on (Ref. to Figure 2.3 and Figure 2.4, Chapter 2, Examples 1, 2 and Exercise 1, 2, Chapter 4, both Cahpters in PART II, No. 3). They are mostly simple cases.

This Chapter presents the method of least squares applied to some selected types of curves together with a special curve.

2.1 Method of Least Squares

The following steps must be followed in estimation of the parameters for the curve (function):

Step 1. Plot the data obtained on a flat surface.

Step 2. Observe the plot to determine what type of function is most likely to be fit.

Step 3. Find the normal equation.

Step 4. Solve the equation for the values of the parameters.

Step 5. Calculate the residual sum of the squares (S) to obtain the error (S/(n-m)), where n is sample size and m is the number of parameters to be estimated.

Note (1) Step 1 and 2 are impossible for data of the kind: $(y_i, x1_i, x2_i \ldots\ldots, xk_i)$, where k ($\geq$2) is the number of independent variables and i is the sample number.

Note (2) The correlation coefficient in the case of a linear function should be calculated.

Note (3) A knowledge of some typical functions and curves is required.

The following table shows some selected curves (functions) with normal equations;

$y = a + bx$	$an + b\Sigma xi = \Sigma yi$ $a\Sigma xi + b\Sigma xi^2 = \Sigma xiyi$
$y = a + bx + cx^2$	$na + b\Sigma xi + c\Sigma xi^2 = \Sigma yi$ $a\Sigma xi + b\Sigma xi^2 + c\Sigma xi^3 = \Sigma xiyi$ $a\Sigma xi^2 + a\Sigma xi^3 + c\Sigma xi^4 = \Sigma xi^2yi$
$y = a + bx + cx^2 + \ldots + qx_p$	$na + b\Sigma xi + c\Sigma xi^2 + \ldots + q\Sigma xip = \Sigma yi$ $a\Sigma xi + b\Sigma xi^2 + c\Sigma xi^3 + \ldots + q\Sigma xip+1$ $= \Sigma xiyi$ $a\Sigma xi^2 + b\Sigma xi^3 + c\Sigma xi^4 + \ldots + q\Sigma xip+2$ $= \Sigma xi^2yi$
$y = a + bx_1 + cx_2 + dx_3 + ex_4$	$\Sigma [yi - (a + bx_1i + cx_2i + dx_3i + ex_4i)] = 0$ $\Sigma x_1i [yi - (a + bx_1i + cx_2i + dx_3i + ex_4i)] = 0$ $\Sigma x_2i [yi - (a + bx_1i + cx_2i + dx_3i + ex_4i)] = 0$ $\Sigma x_3i [yi - (a + bx_1i + cx_2i + dx_3i + ex_4i)] = 0$ $\Sigma x_4i [yi - (a + bx_1i + cx_2i + dx_3i + ex_4i)] = 0$
$y = ax^b$	$\log yi = Yi, \log a = A, b = B, \log xi = Xi$ $An + B\Sigma Xi = \Sigma Yi$ $A\Sigma Yi + B\Sigma Xi^2 = \Sigma XiYi$
$y = ae^{bx}$	$\log yi = Yi, \log a = A,$ $An + b\Sigma xi = \Sigma Yi$ $A\Sigma xi + b\Sigma xi^2 = \Sigma xiYi$

2.2 Special Curve

The curve dealt with here is a so called growth curve that is often applied to express various types of growth trends, for example, the spread of durable consumer goods (television, passenger vehicles, etc.).

We have two types of growth curves, that is, the Logistic curve and the Gomperts curve. The two curves are expressed, respectively, by

$$\log_e \frac{y}{k-y} = a+bt \qquad \text{.....(1)}$$

and

$$\log_e \frac{y}{k-y} = a+bt+ct^2+dt^3 \qquad \text{.....(2)}$$

where

k, a, b, ... and d are parameters

The explicit form of expression (1) is

$$y = k/(1+me^{-bt}),\ m=\exp(-a) \qquad \text{.....(3)}$$

The parameters are estimated in the following way

$$z = p+qy \qquad \text{.....(4)}$$

where,

$Z = \Delta y/y$, $p=b$, $q=-b/k$ and

Δy= increase during successive time periods (between t and $t+\Delta t$, $\Delta t=1$)

Then method of least squares is applied to eq. (4) to determine the values of parameters p and q, from which b and k are calculated. The value of parameter m is given by

$$m = e^{bto}$$

in which t_o is the time period corresponding to $y_o=k/2$. This method for the value of m is applicable only when the value y_o is covered by the original time series data of y, that is, {y1, y2, ..., y_t, ... }. Otherwise another method must be used for the value of m.

The above method for the value of m depends on the fact that the Logistic curve has a single inflection point, which is given by $d^2y/dt^2= 0$ ($dy/dt > 0$ in this case).

Exercise. Find (to, yo) from $d^2y/dt^2= 0$.

Exercise. Try to form an explicit expression of the Gomperts curve given by eq. (2).

Exercise. Find the normal equations of functions

$y = a+bx+cx^3$ and $y = a+bx_1 + cx_2 + dx_3$

3. Time Series Analysis

Time series analysis is done to forecast a characteristic series for the future based on time series data from the past. For example, data x_t observed at time t is often considered to be separable into two components, that is

$$x_t = f_t + \varepsilon_t$$

where ft is considered to be of some deterministic trend and ε to be random. We can suppose that f_t and ε_t will both play very important and characteristic roles in the appearance of x_t.

For this reason the characteristic natures of f_t and ε_t are analyzed.

In the present section we are concerned with some simple but important methods of time series analysis; moving average and exponential smoothing.

3.1 Moving Average Method

This is applied to derive a smoothed trend from original time series data to give us some information about a future trend, because the method eliminates certain kinds of fluctuations, that are regarded to be caused by seasonal effects, random events and so on.

A new time series is obtained from

$$\left.\begin{aligned} y_{m+1} &= \frac{1}{2m+1}(x_1+x_2+\ \cdots\ +x_{m+1}+\ \cdots\ +x_{2m+1}) \\ y_{m+2} &= \frac{1}{2m+1}(x_2+x_3+\ \cdots\ +x_{m+2}+\ \cdots\ +x_{2m+2}) \\ y_{n-m} &= \frac{1}{2m+1}(x_{n-2m}+x_{n-2m+1}+\ \cdots\ +x_{n-m}+\ \cdots\ +x_n) \end{aligned}\right\} \quad \cdots\cdots (5)$$

where,

$x_1, x_2 \ldots x_n$: original time

$m = 1, 2, \ldots\ldots$

y_i $(i = m+1, m+2, \ldots, n-m)$ is called the moving average at time i.

The newly obtained series $\{y_i\}$ is the arithmetic mean of the $(2m+1)$ original data series. The method is called the moving average of $(2m+1)$ terms. Note that $2m+1$ is an odd number for $m=1, 2, \ldots$.
Usually, an odd number is adopted as the number of terms for a moving average because this facilitates calculation.

In the case of an even number of terms, the new series is calculated from

$$\left.\begin{aligned} y_{m+1} &= \frac{1}{2m}\left(\frac{1}{2}x_1+x_2+\ldots+x_{m+1}+\ldots+x_{2m}+\frac{1}{2}x_{2m+1}\right) \\ y_{m+2} &= \frac{1}{2m}\left(\frac{1}{2}x_2+x_3+\ldots+x_{m+2}+\ldots+x_{2m+1}+\frac{1}{2}x_{2m+2}\right) \\ y_{n-m} &= \frac{1}{2m}\left(\frac{1}{2}x_{n-2m}+x_{n-2m+1}+\ldots+x_{n-m}+\ldots+x_{n-1}+\frac{1}{2}x_n\right) \end{aligned}\right\} \quad (6)$$

Each of $\{y_i\}$ is a result of double moving averages.

For example,

$$y_{m+2} = \frac{1}{2m}\left(y'_{m+2} + y''_{m+2}\right)$$

in which,

$$y'_{m+2} = \frac{1}{2m}\left(x_2+x_3+\ \ldots\ +x_{m+2}+\ \ldots\ +x_{2m+1}\right)$$

$$y''_{m+2} = \frac{1}{2m}\left(x_3+x_4+\ \ldots\ +x_{m+2}+\ \ldots\ +x_{2m+1}+x_{2m+2}\right)$$

The foregoing is called simple method of moving average because of the uniform weight of x_t.

Another method of moving average is the weighted moving average. The weighted moving average of (2m+1) terms is calculated from

$$y_i = \frac{1}{c}\left(c_0x_{i-m}+c_1x_{i-m+1}+\ldots+c_mx_i+\ldots+c_{2m}x_{i+m}\right)$$

where,

$c = c_0 + c_1 +\ldots+ c_m +\ldots + c_{2m}$

c_m = weight for data x_i

y_i = weighted moving average at time i

Note: The value of weight c_m is given according to the number (2m+1). For example, $\{c_0, c_1, \ldots, c_4\} = \{-3, 12, 17, 12, -3\}$ for 2m+1 = 5 (m=2). Usually, the value of c_m is the maximum of these, which means that x_i is the most important for obtaining new data y_i. It should be recalled that y_i corresponds to x_i.

The moving average method successfully eliminates fluctuations caused by seasonal/random/etc. effects and permits deviation of a smoothed trend. It is also applicable for the preparatory processing of original data. In cases in which the original time series data are over a wide range and frequently fluctuate in time (like monthly data), the method of least squares may be sometimes successfully applied to newly obtained time series data because the new data are of smoother trend than the original.

3.2 Exponential Smoothing Method

The method is expressed by:

$$y_i = y_{i-1} + \alpha(x_i - y_{i-1}) \qquad (8\text{-}1)$$

or

$$y_i = \alpha x_i + (1-\alpha)\, y_{i-1} \qquad (8\text{-}2)$$

where

y_i : expected value at time i

x_i : realized (observed) value at time i

α : parameter $0 \leqq \alpha \leqq 1$

The method includes some probabilistic concepts. Note that the expected value y_i is not equal to the observed value x_i if $\alpha = 1$. That is, the observed value is regarded as appearing from the probable values and y_i is the expected value of these.

Eq. (8-2) leads to

$$y_i = \alpha x_i + \alpha(1-\alpha)x_{i-1} + \alpha(1-\alpha)^2 x_{i-2} + \ldots\ldots \qquad (9)$$

which has been proved to be a type of weighted moving average since the sum $\{\alpha + \alpha(1-\alpha) + (1-\alpha)^2 + \ldots\}$ of weights is equal to unity. Note that $0 \leqq \alpha \leqq 1$ and so we have $\alpha \geqq \alpha(1-\alpha) \geqq \alpha(1-\alpha)^2 \geqq \ldots$, which means that the older data is less weighted in the estimation of the present expected value. The following aspect of this method should be noted; the method can be successfully applied to time series data which has no deterministic trend (time-dependently increasing/decreasing/seasonal/cyclical).

Other methods of exponential smoothing are applicable to data which has some deterministic trend. These are called exponential smoothing methods of the 2nd or 3rd order. In this context the foregoing method has been described as of the 1st order.

Second order smoothing is given by double smoothing as follows:

$$\begin{aligned} Z_i &= \alpha y_i + (1-\alpha)Z_{i-1} \\ y_i &= \alpha x_i + (1-\alpha)y_{i-1} \end{aligned} \qquad (10)$$

from which the expected value at time i is given by

$$2y_i - Z_i$$

The 2nd order method is applied to series of data linearly decreasing or increasing in time. The smoothing factor α is determined so as to be a best fit to the data obtained in the past.

The expected value y_i or $2y_i - Z_i$ at time i can be adopted as the forecast value at time i+1.

4. Route Choice Problem

In a system for Canal traffic analysis and short term transit forecasting, the route choice problem is examined last, just prior to Canal traffic forecasting (Ref. to Chap. 1, PART 2 No. 3).

(1) World trade is determined by the distribution of production and consumption world-wide and also as affected by each government's policy. Some of the methods mentioned in the previous sections are applicable to this analysis/short term forecasting of production and consumption of energy/oil/non-oil.

We have only to solve the equation:

domestic production plus imports
= domestic consumption plus exports.

(2) Sea-borne trade operates, in general, competitively with the other transportation modes; railways, pipeline, roads and airplane.

The general theory of model sharing of transportation seems to be incomplete at the present time. In the study of transportation planning theory various explanatory variables have been selected to estimate/forecast the modal split. These include; spatial/transportation distance, transportation time, rate/fare, capacity, proper characteristics of mode/commodities/passengers and so on.

In short term forecasting of world sea-borne trade, the competitive transportation modes may be regarded as unchanging in conditions. This may lead us to believe that world sea-borne trade has a proper part of world trade. Sea-borne trade has a larger share of the world trade of oil, oil products, grain, coal and iron ore because of its relatively low transportation rate and because of the separation by sea of the major importing/exporting (or consuming/producing) countries/areas (Ref. to Chap. 3, PART 2, No. 3).

Short term forecasting of sea-borne trade will be done using the methods mentioned above.

(3) When sea-borne trade (with its OD table) and world fleet are known, the route choice problem has to be solved based on the conditions of freight rates, sea-distances, ship costs, transit times, tariffs and Canal capacity. The transit time, tariff and Canal capacity are under SCA's control. The Suez Canal route is competitive with other sea routes.

The problem may be called "a minimum route problem" dependent on Canal capacity. That is, when freight rates, sea distances, ship costs, transit times and tariffs are converted into a generalized factor (generalized cost), each route has its proper value of the factor. We have then only to determine the route of minimum value of the factor when other conditions obtain (Canal capacity is most important).

For the solution of the minimum route problem, refer to Chapter 5, PART II, No. 3 by Prof. Haruna and Chapter 6, PART II, No. 3 prepared by Prof. Yamamoto.

FOR SCA INTERNAL USE ONLY

No. 5

WORKSHOP OF JOB INITIALIZATION OF THE ECONOMIC UNIT

No.5 WORKSHOP OF JOB INITIALIZATION OF THE ECONOMIC UNIT

PREFACE

This No.5 curriculum text is a compact compilation of the detailed texts on the subject of "Workshop of Job Initialization of the Economic Unit" to be distributed in advance to the participants of the Suez Canal Authority for the training program in Japan which will be held on December 18-22, 1978 at Mitsubishi Research Institute.

Workshop of job initialization of the Economic Unit, the last training curriculum in Japan, is designed primarily to serve the purpose to prepare trainees for initializing the actual research work. It is planned that the actual research jobs will commence from April 1979 and that the staff members of the Economic Unit will start working on specific research projects or programs which are assigned to them. For this purpose, the following subjects will be taught and discussed at this stage of the training, referring to the actual conditions existing at the SCA:

1) Methods and techniques required for planning, execution and control of the research project.
2) Methods and techniques required for the research organization management.

The nature and objectives of this course could, therefore, be understood as a combination of two separate disciplines; one is a business research methodology course and the other is a research management course. However, these two courses have rarely been taught in a combination either at business schools or at graduate schools in any social science fields, therefore no good textbook is readily available which would be suited to the levels of the education and experience of the SCA's trainees. In order to cover the lack of a standard textbook in these fields, a series of lectures are to be given on what are regarded as essential or fundamental for the Economic Unit, while selecting various problems, methods and techniques from a number of management science textbooks.

In order to supplement the present course, the trainees will be instructed at the end of the workshop in order to continue their self-training program. For this purpose, problem exercises, assignments and reading lists are provided in the appendix of the present workshop lecture textbook.

This text was prepared by Dr. Morimitsu Inaba of Mitsubishi Research Institute.

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ANNEXES

CHAPTER 1 PLANNING AND DECISION MAKING OF THE SCA MANAGEMENT AND INFORMATION AND RESEARCH NEEDS

1.1 Objectives of Information and Research Services

The major information and research services that are provided by the Economic Unit to the SCA management must be those which will be found useful for planning and decision making functions of the SCA management.

It must be clearly understood that the Economic Unit's research information must directly help the SCA managers to make a rational decision, i.e., to avoid losses and increase profits. The SCA's decision makers will always face the questions; How can this problem be solved? What will be the best solution to the problem? What kind of information do I have to have to make a decision? etc. In the simplest terms, the value of research information can be defined as "the difference between results of decisions made with the information and results obtained without it.

Viewed in this way, the Economic Unit's research and information gathering must produce added revenues or reduce expenses in much the same way as any other investment of resources of the SCA.

(1) Contribution of Research to Decision Making

The Economic Unit's research have value to the extent that it assists management to make better decisions. If a given study does not give promise of helping to identify more efficient, less riskly or more profitable alternatives than could otherwise be obtained, the value of the study will be in question. This simple precept should always be borne in mind by all the staff members of the Economic Unit; "applied research in a business environment finds its justification in the contribution it makes to the decision makers' task." Unlike a research institute, academic or non-profit making organization, the Economic Unit has a clearly defined mission to positively contribute to the SCA management planning and decisions.

(2) Cost-Effectiveness

In order to collect information and data and to carry out a study on a certain management problem, the Economic Unit must use a variety of inputs such as

the man-hours of research staffs, research materials and supplies, office facilities and equipment, etc. These inputs must be efficiently and effectively organized and used to produce valuable information and research results; the output of the Economic Unit. Therefore, economic consideration of how the Economic Unit's activities should be carried out in terms of comparative judgement of the research costs and value of output will always be of serious concern to the Economic Unit.

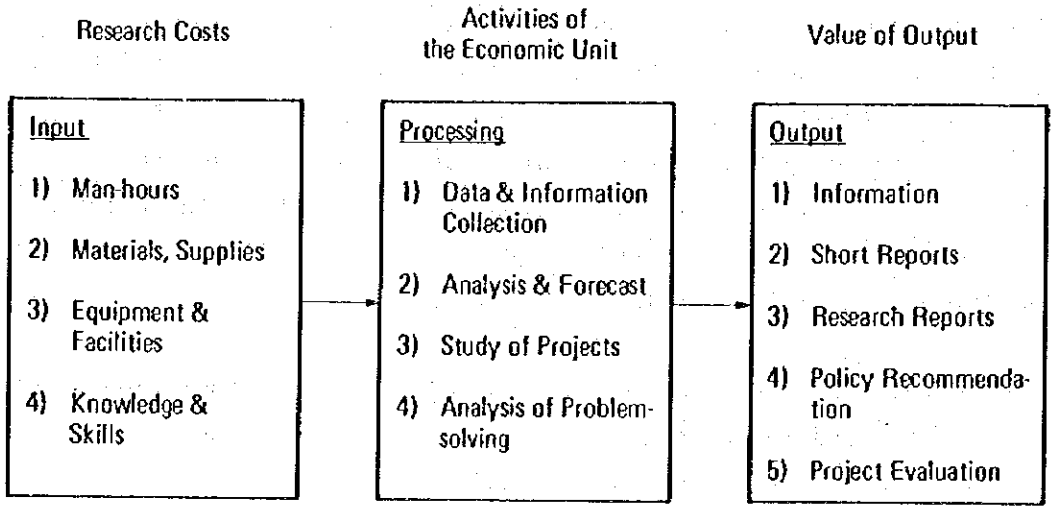

Fig. 1.1 Research Costs & Value of Research Output

(3) Criteria of Evaluation of the Economic Unit

It must be apparent that how the objectives of the Economic Unit are achieved will be evaluated from two kinds of criteria; one is the value of the output produced by the Economic Unit and the other is how effectively and efficiently necessary input are processed by the Economic Unit into the output. Staff members of the Economic Unit must be aware that their research activities will always be evaluated and judged by the SCA management by these criteria. Some of the major measurements or indicators of how their research performance will be evaluated is shown in Table 1.1.

Table 1.1 Judgement Criteria of Performance of the Economic Unit

Value of Output	Activities of the Economic Unit
1. Relevancy	1. Cost-effectivenss
2. Applicability	2. Efficiency & Effectivenss
3. Action-orientendess	3. Productivity
4. Translatability into Policy	4. Quality Control
5. Recommendatory	5. Accuracy & Exactness
6. Contribution to Profit Optimization	6. Timelyness
7. Reduction of Uncertainty	7. Reliability & Validity
8. Problem-solving	8. Regularity
9 Conflict Resolution	9. Promptness & Punctuality
etc.	10. Lack of Redundancy & Contradictions
	11. Clarity & Logicality
	12. Communicability & Persuasiveness
	etc.

(4) Difficulty in Judging the Value of Research

As can be seen in Table 1.1, the indicators listed for the evaluation criteria of the Economic Unit's activities are those which can be easily measured and objectively assessed. On the contrary the indicators of the value of the research output may raise some serious difficulty, for they are not so easily evaluated according to certain objectives and/or quantitative measurements. Because of this, it must be remembered that the value of the research work of the Economic Unit may always be subject to questions in the minds of the SCA management. In light of this, every possible effort must be exerted by the Economic Unit to remind the SCA management of the value and necessity of the research and information services. On this score, the following strategies and policies will become necessary:

1) Try to understand specific information needs of the SCA management.
2) Produce research output and provide an information service to exactly meet the information requirements of the SCA management.
3) Raise the credibility level of the Economic Unit
4) Select certain research areas in which the Unit can best contribute to the SCA's management.

The first strategy or policy must be considered as of primary importance for the Economic Unit in the initial years, as it is required that the Economic Unit must select certain research programs and projects according to the priority order of the SCA management information requirements.

For the purpose of identifying the SCA management information requirements, staff members of the Economic Unit should constantly raise the questions listed in Table 1.2 so that their research work may not deviate from the proper work directions set out on a specific research topic.

Table 1.2 Questions Must be Raised to Identify the SCA's Management Information Needs

1. What types of decisions are they called upon to make?
2. What types of information do they need to make these decisions?
3. What types of information are they receiving on a regular basis?
4. What types of special studies do they periodically request?
5. What types of information do they want to get that they are not getting now?
6. What kinds of information are required by them daily? weekly? monthly? quarterly? yearly?
7. What magazines and trade reports do they want to see routed to them on a regular basis?
8. What specific topics do they want to be kept informed of?
9. What types of data-analysis program do they want to see made available?
10. What kinds of specific requests do they make to improve the present decision making process and management information flow in the SCA?

1.2 SCA's Planning Functions and Its Information Needs

All management theories agree that planning is a major element of the managerial functions. However, there is no general agreement concerning precisely what constitutes planning. In this section, the SCA management planning functions are defined as encompassing the activities which are variously referred to as "goal setting, policy making and decision making relating to the future problems of the SCA."

The definition implies that the SCA management planning involves the identificaton of the broad goals of the SCA and the specification of strategic policies which prescribe the way in which the SCA will go about achieving its goals. Therefore, the SCA's planning could be considered as encompassing the following activities:

1) The identification of opportunity areas for further SCA's activity.
2) The assessment of the assumptions, operational principles, modus vivendi and organizational structure of the SCA.
3) The assessment of SCA's economic and non-economic responsibility to the Egyptian economy and society, and its clientele, i.e., shipping companies and others.
4) The forecasting of future SCA environments and technologies that may seriously affect SCA's Canal operations and revenues.
5) The contrivance of the strategies and process by which the future goals can and must be achieved.

If the SCA management planning is defined as above, the "second Canal expansion project" should be regarded as the most serious management planning problem that may face the SCA in the future.

(1) Types, Fields and Process of Management Planning

It must be understood that management planning can be classified into different hierarchical levels on the basis of the planning time horizon. Three levels frequently referred to in the management theory are "strategic planning," "tactical or management planning," and "operational planning" (see R.N.ANTHONY, Planning and Control Systems : A Framework for Analysis, Harvard University Press, Cambridge, Mass., 1965.) They correspond roughly to long-term, middle-term, and short-term planning. The meanings of

planning are shown in Figure 1.2.

(2) The Economic Unit's Required Information & Research Services

The Economic Unit must ask itself; what kinds of information and research services must be provided by the Economic Unit in assisting the SCA management to carry out rational and optimal plans? In order to identify the various tasks that are required of the Economic Unit, careful consideration should be given to the following problems:

1) What type of planning problem is asked to be analyzed? It is a strategic plan? Or a management plan? Or an operational plan?
2) What functional areas is the planning aiming at? Is it related to the SCA's marketing problems or operational service problems?
3) At what stage of the planning process is the Economic Unit requested to make a technical study?
4) Is the SCA management concerned with specific project planning?

The following indicates some of the major characteristics of the types of study that must be made by the Economic Unit:

1) The strategic planning problems are closely related to the long-term and external problems of the SCA that require "forecasting analysis," "information gathering on general trends," "overall analysis of the problems involved" and "policy recommendations," etc.
2) On the other hand the management and operational planning problems are more or less related to the internal problems of the SCA that require "fact finding study," "decision making and problem-solving study." "action-oriented study," and "in depth study," etc.
3) Similar types of consideration should be given to the SCA's problems that are dealt with in the SCA's planning activities.

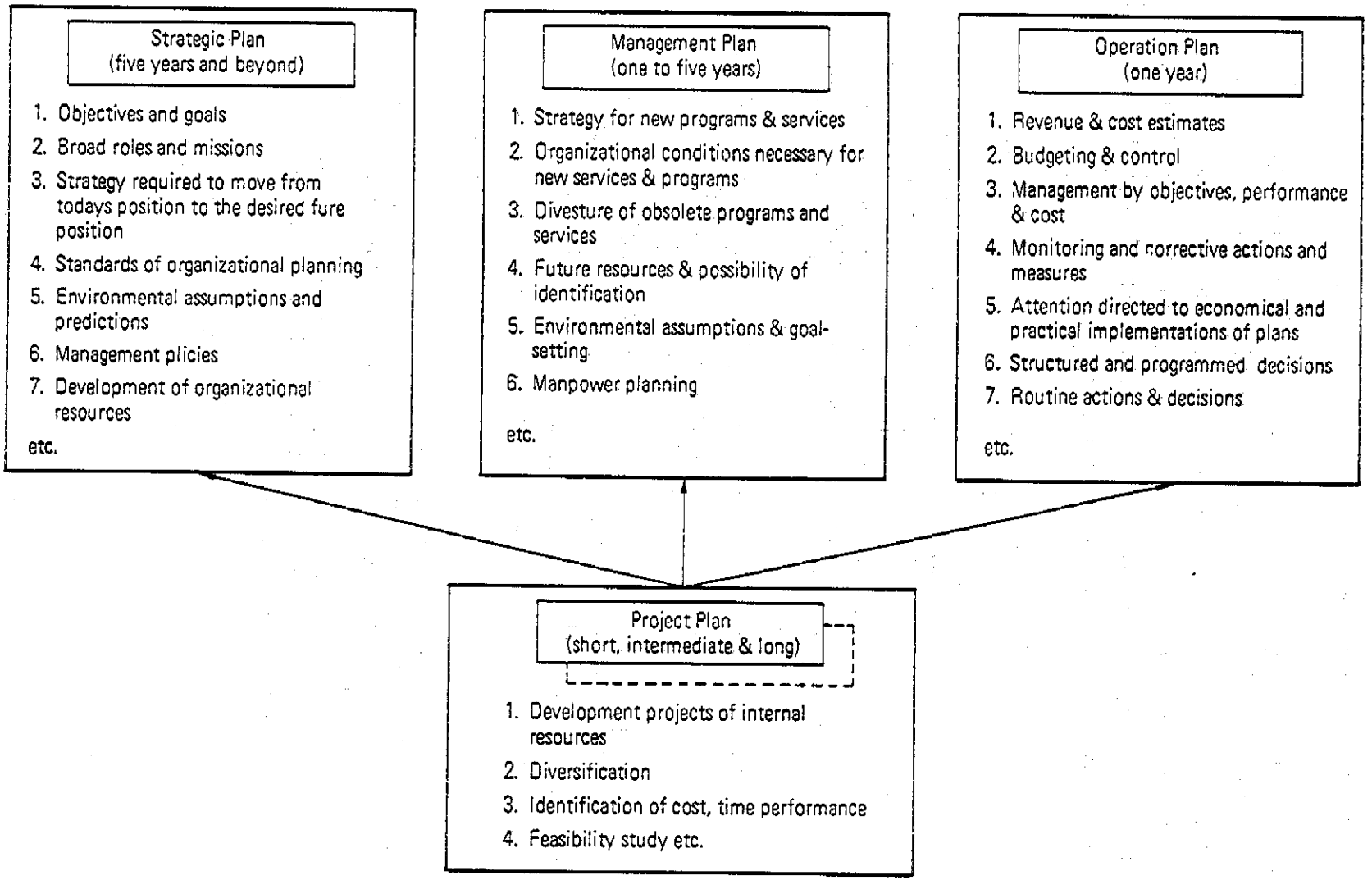

Fig. 1.2 A System of Plans

1.3 Decision Making Problems of the SCA Management and Information Needs

The SCA management decision making problems could be best understood when they are regarded as sequences of the actions required to find the solution. The action processes are typically broken down into the following segments:

1) Defining the problem
2) Analyzing the problem
3) Developing alternative solutions
4) Selecting the best solution
5) Converting the solution into effective action

(See Systems Analysis and Project Management, by D.I. Cleveland and W.R. King, McGraw-Hill, 1975, p.220)

The definition mentioned above may suffice to understand what is implied by the term, "management decision making."

In order to have a clear understanding of what kinds of information and research work are required of the Economic Unit to assist the SCA management in making a rational and optimal decisions, staff members of the Economic Unit must know the nature, types and process of the management's decision making. In the following some of their important aspects are explained.

(1) Nature, Types, and Process of Decision Making

The SCA's management decision making could be classified into several types according to how much their decision making actions are structured, routinized, and made in terms of the prescribed rules and procedures. They are as shown in Figure 1.3.

1) Non-programmed and programmed decisions
2) More structured and less structured decisions
3) Higher and lower level of management decisions
4) Strategic, management, operational and transactional decisions.

As might be seen in the Figure, the types of decisions made are closely related to the level of the management who makes them.

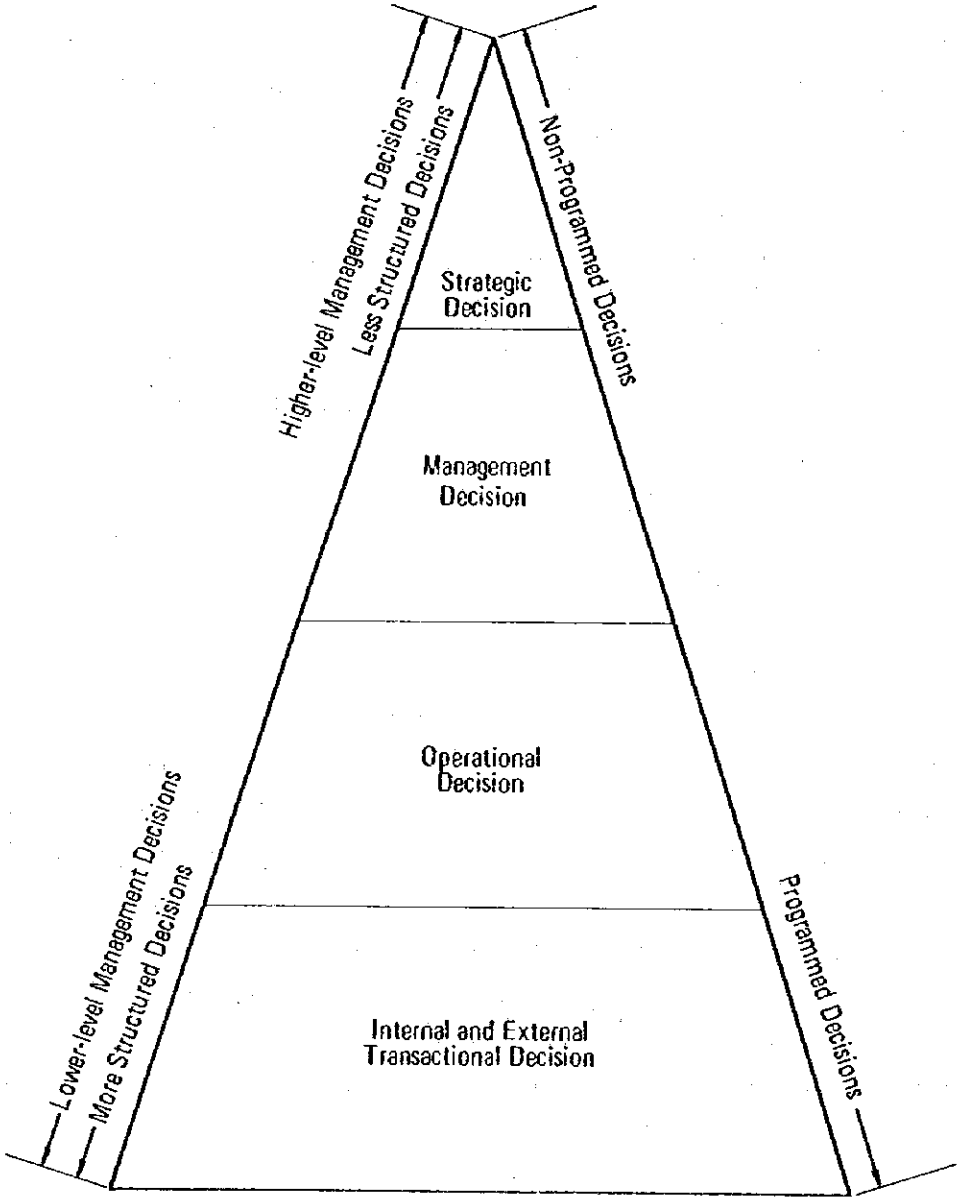

Fig. 1.3 Types of Decisions

(2) Type of Information and Research Work Required

It must be understood that an information analyst, an economic and financial analyst and a systems analyst may have to participate in each stage or phase of the decision making process. However, the type of research work and the degree of quantitative analysis required will depend upon the stage at which the staff members were requested to make studies. It is shown in Figure 1.4 and Table 1.3 what kind of research work is required for the Economic Unit. Readers should pay careful attention to what is indicated in the Figure and Table. In addition, when an analytical model is to be constructed, they must be cautious about the selection of the types of variables that will be included in the model. The nature of some of the basic types of variables were already explained in the previous lectures. As a reminder, major types of variables and other methodological problems are enumerated below:

Types of variables
Independent and dependent variables
Explanatory and predetermined variables
Policy and decision variables
Endogenous and exogenous variables
Intervening variables
Controllable and uncontrollable variables
Dummy variables
Substitute and proxy variables
etc.

Methodological assumptions and problems
Behavioral, definitional and structural equations
Cetris paribus conditions
Assumption of linearity
Fixed coefficient
Internal and external constraints
etc.

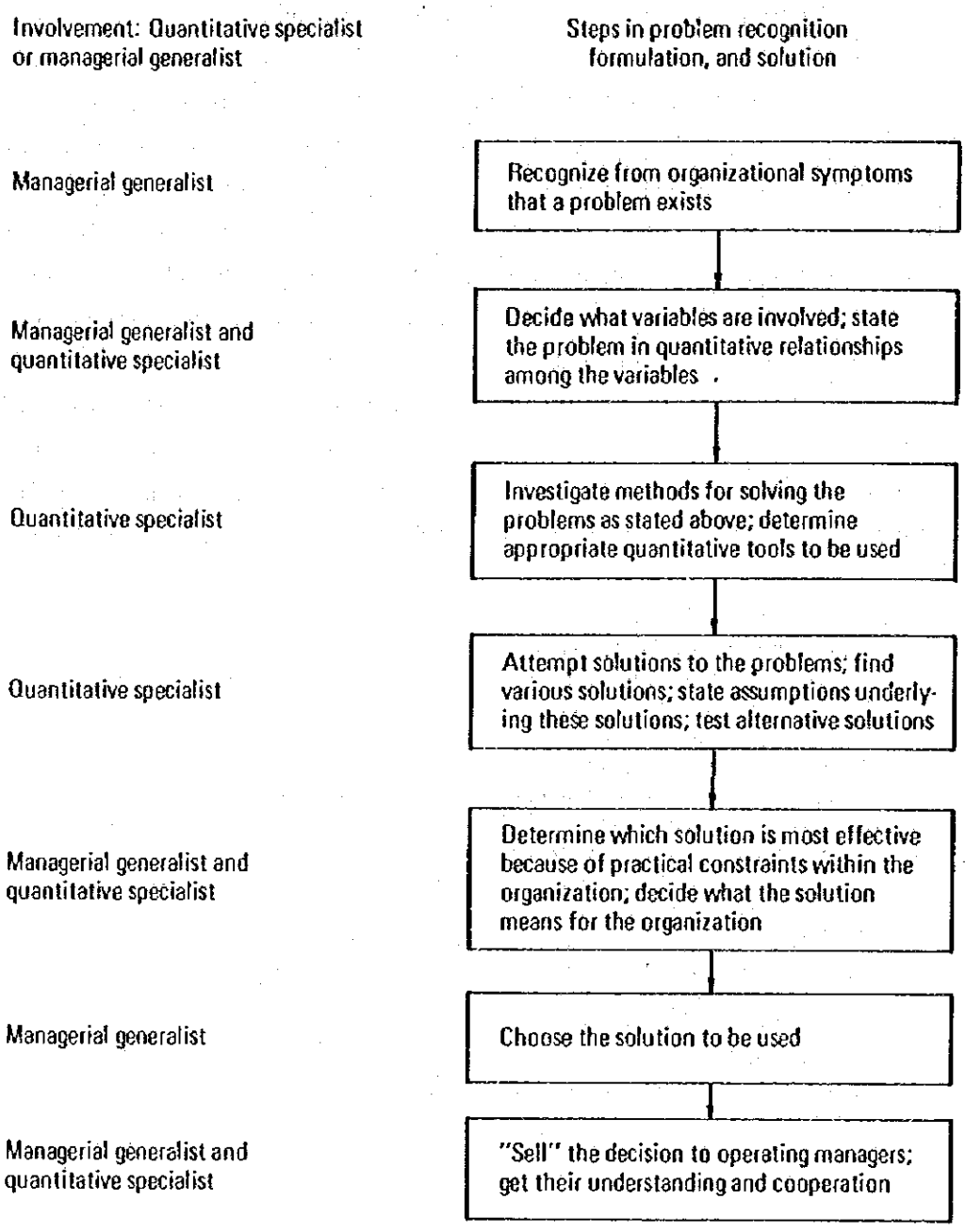

Fig. 1.4 Roles of Quantitative Specialist and Managerial Generalist in Decision-Making

Table 1.3 Decision Process and Type of Research Required

	Problem Identification & Setting	Management Task Definition	Solution Finding	Implementation and Control
Types of Management Needs, Questions & Activities	1. To set the purpose & the basic end 2. To formulate goals explicitly 3. To clarify the assumption 4. To set priorities 5. To delineate conflicting goals etc.	1. Identifications of specific problems to achieve the goals 2. To find the conditions that must be changed 3. Search for major factors that account for the problems 4. Degree of difficulty in achieving the objectives 5. Requirements of course of action etc.	1. Identification of alternatives 2. Priorities of choices 3. Degree of feasibilities 4. Cost/benefit of solutions 5. Impacts of a choice 6. Selection of an optimum decision 7. Methods of implementation and planning etc.	1. Establishment of monitor, follow-up and control policies and measures 2. Policies of project and program planning & control problems 3. Technical, schedule, cost & funding status and control problems 4. Discovery of delays & deficiencies and methods of corrective actions etc.
Types of Research Needs, Questions & Activities	1. Fact findings 2. Information gathering 3. Exploration 4. Trend identification 5. Review of the latest events & reports 6. Discovery of symptoms of the problems etc.	1. A diagnostic research 2. Uncovering the cause of unsatisfactory conditions 3. Descriptive & analytical research 4. Identification of major factors & variables 5. Forecasting analysis 6. Status report 7. Analysis reports etc.	1. Business economic studies 2. Operations research 3. Feasibility studies 4. Cost/benefit analysis 5. Policy analysis reports 6. Management strategy reports 7. Management actions reports etc.	1. Management science studies 2. Project & program control studies 3. Management decision reports 4. Program evaluation & review technique (PERT) studies 5. Project status reports etc.

CHAPTER 2 TYPES AND FIELDS OF MANAGEMENT RESEARCH

2.1 General Remarks

In this chapter a short description will be made concerning the following problems:

1) What kinds of theories and methods are actually used in business management problems?
2) How are specific business problems studied by technical methods that are best suited to them?
3) How will the research work be classified? What kind of research is it that the Economic Unit is most likely to undertake?

The table and list are used to map out how these problems are mutually related to each other in actual research work and also to create a clear view of the theories, methodologies and their application fields. The descriptions provided in this chapter should be used as a reference by staff members of the Economic Unit so as to understand the following:

1) A direction toward which they have to go
2) The research work they are doing must be clearly defined within the content of the management research fields
3) How their work will be related to other fields of management research.

During the workshop lecture, enough explanation will be provided with regard to what kinds of theories, methods and techniques must be used to analyze specific problems of the SCA management.

Table 2.1 lists the types of theories and methods which are commonly used by business analysis in specific application fields.

In the following section, research is classified into several types according to 1) the degree of depth of study, 2) objectives of research, 3) functional areas of management problems and 4) the types of methods or disciplines used. It must also be remembered that some kinds of management research theories and methods used in the business world could also be effectively applied to similar problems of any public enterprise such as the SCA.

Table 2.1 Theories, Methods and Application Fields of Management Research

Theories & Methods		Application Fields	
1. Statistical Methods 1) Frequency distirbutions 2) Correlation & regression 3) Time series analysis 4) Index number 5) Probability distributions 6) Inference 7) Statistical test 8) Variance analysis & experimental design 9) Non-parametric inference 10) Sampling theory 11) Statistical control 12) Marcov process 13) Multivariate analysis 2. Economic Analysis 1) Demand analysis & forecast 2) Sales analysis & forecast 3) Investment analysis & decision 4) Economic analysis of costs 5) Pricing decision 6) Market analysis 7) Management finance & cost analysis 3. Management Science 1) Linear programming 2) Game theory 3) Dynamic programming 4) PERT (Program evaluation & review technique) & CPM (Critical path method)	5) Inventory planning & control 6) Queing theory 7) Simulation 8) Industrial dynamics 9) Informatio theory 10) Systems analysis 11) Time & motion study 12) Process planning & control 13) Value analysis 4. Behavioral Science 1) Psychometric measurement 2) Psychological tests 3) Human engineering 4) Organizational analysis 5) Job analysis 6) Performance evaluation 7) Training & evaluation 8) Morale survey 9) Interview analysis 10) Counselling 11) Market survey analysis	1. Research for Long Term Planning 2. Management Accounting 1) Financing plan 2) Profit plan 3) Budget plan & control 4) Cost management 5) Internal audit 6) Investment plan 3. Office Management Research 1) Office equipment plan 2) Space design 3) Office system 4) Record keepings 4. Marketing Management Research 1) Product planning 2) Distribution & channel 3) Sales promotion 4) Pricing decisions 5) Sales forces 5. Production Management Research 1) Production planning 2) Plant layout 3) Maintenance 4) Material handling 5) Quality control 6) Contract management	6. Personnel Administration Research 1) Manpoer palnning 2) Recruiting policy 3) Job description analysis 4) Training & performance evaluation 5) Promotion & transfer 6) Employee disciplines 7) Wage & salary policies 8) Management of human resources 7. Other Fields 1) Managing external relations 2) Data processing & Management information system 3) International operations 4) Project planning & control 5) Project evaluation 6) Feasibility study

2.2 Types of Research

(1) Classification by Degree of Analysis

1) Information-gathering

The basic nature of this type of research is to gather information which is pertinent to management problems; the information gathering could be made on a periodical or non-periodical basis. Reporting on a specific or timely topic is a common task, yet information may be difficult to find and the assignment may call for knowledge of, and skill with, information sources.

2) Descriptive Research

This is a higher order of study objective, going beyond reporting facts, events, trends, news, etc. The researcher seeks out a wide range of information of relationships of variables and their changes; i.e., growth rates, percentage distribution, correlations, elasticity of changes, seasonal variation, cyclical changes, etc.

3) Forecast or Prediction

Independent and dependent variables are identified and certain facts and assumptions are formulated into explanatory hypothesis as a basis of prediction of the outcomes of various courses of action and/or events. This type of study is substantially more sophisticated than the first two. Regression analysis, simultaneous equations, simulation and systems dynamics, etc. are used as the forecasting tools.

4) Explanatory Research

This is a type of scientific method research by which the problems under study are explained in terms of empirical hypothesis of events and/or occurrence of facts. The hypothesis is tested through experimental design and/or by other statistical methods.

(2) Classification by Objectives of Research

1) Basic Research

The objective of basic research is; to discover and describe pheno-

mena, to establish new relationships between phenomena and to predict behavior without considering immediate goals of practical application in the business world. This type of research is not a primary consideration of the E.U.

2) Applied Research
The objective of this research is not to make a scientific discovery of the phenomena but to find facts and predict events for a specific purpose of application of the result in the world; e.g., market research, sales forecast, logistic analysis, inventory control analysis, O/D of specific commodities, etc. This is a type of the research that the E.U. must undertake.

(3) Classification by Functional Areas of Problems

1) Market Research
This research aims at the specific problems of marketing functions of an organization; such as development of market potential, market-share analysis, determination of market characteristics, sales analysis, distribution cost and channel study, test market, consumer panel, etc. The Suez Canal's environment studies could be classified as market research for the SCA.

2) Product Research
This deals with new-product acceptance and potential, competitive product studies, product testing, packaging research, etc. which was little relation to the SCA's research needs.

3) Business Economics & Corporate Research
This is the most important field of research for the E.U.; typical examples are short-range forecasting, long-range forecasting, studies of business trends, profit and loss analysis, plant and warehouse location studies, procurement and inventory control studies, export and international studies, linear programming, operations research, PERT studies, employee morale studies, etc.

(4) Classification by Methodologies & Discipline

1) Economic Analysis

One of the major types of research undertaken by the E.U., a type of research through which the SCA's economic problems, internal and external, are analyzed. The methods and/or disciplines used are international economics and trade, maritime transport economics, econometrics, managerial economics, business mathematics and statistics, etc.

2) Systems Analysis

This research tackles interrelations and interdependence of the systems components of a problem; a system could be physical, operational, economic, managerial, social and political. When the systems analysis method is used for management decision problems, it is indistinguishably mixed with "operations research" and "management science".

3) Behavioral Science

This deals with human problems from a standpoint of inter-disciplinary approaches to social sciences, and sociology, psychology and statistics are major disciplines. This approach is frequently used for the studies of consumer behavior, organizational behavior, political behavior, etc. This approach could be used by the E.U. in its research on problems of administrative problems of the SCA such as leadership, morale, achievement orientation and other personnel administrative problems.

4) Survey Research

When hard data such as statistical data are not available and particularly when the study objectives are to analyze peoples opinions, attitudes, needs, demands, etc., this research method is used. This research requires skills in sample design, questionnaire construction, scaling, and non-metric data analysis etc. This research method could be used by the E.U. in such fields as attitude survey of the SCA's management and employees, shipping companies management opinion survey etc.

5) Cost-Benefit Analysis

Cost-benefit analysis is a practical way of assessing the desirability of projects which require the enumeration and evaluation of all the relevant costs and benefits. The cost-benefit analysis is a way of setting out the factors which need to be taken into account in making certain economic choices. Most of the choices to which it has been applied involve investment projects and decisions to whether or not a particular project is worthwhile, which is the best of several choices, or when to undertake a particular project. This research is considered as one of the most useful tools for the E.U. in its task of "project evaluation" of the SCA.

6) Financial & Cost Analyses

Financial and cost analyses are the two major fields of management accounting which will also be dealt with by the E.U. The former analyzes the financial position of an organization through a balance sheet, income statement, statement of changes in financial position and the latter analyzes cost behavior and structure of the organization's activities and operations.

CHAPTER 3 RESEARCH PLANNING, IMPLEMENTATION AND CONTROL

3.1 Introduction

The problem of how to plan, implement and control a specific research program or project should be conceived by all the members of the Economic Unit as one of the most important tasks which will continuously confront them from the very beginning. It must be understood that neither graduates of the social sciences nor those from engineering fields will be able to become good professional research analysts unless they are properly trained and experienced in the technical tasks of research planning and control. No matter how excellent their academic records were at their university level of education, they must first acquire knowledge and skills to plan, implement and control the research project. It usually takes several years' experience before they become proficient in carrying out these required tasks.

In light of this, the present chapter should be read very carefully by all members of the Economic Unit. Although in this chapter, only the fundamentals of the research methods are explained, during the workship lecture every possible effort will be made to explain various technical details and ramifications that are entailed in research planning and control problems.

3.2 Research Planning

(1) An Outline of a Research Plan

For any kind of research program or project, a chief researcher or a project team leader must first of all draw up an outline of the research work that was assigned to him or that he planned to execute on his own initiative. The research outline should be written as briefly as possible, indicating just the essential elements of the research process. A typical research plan must include the following as summarized in Table 3.1:

1) Research objectives
2) Specification of research questions
3) Research techniques that are planned to be used
4) Conceptual flowchart of problems and work
5) Indication of the research schedule

6) Organization of a research project team
7) Estimate of time and cost budgets
8) Method of progress and cost control

(2) Research Process

In order to plan as well as to execute a research project, one must have a clear picture of how the research work will progress and what kinds of problems are likely to arise as the work progresses. In the broadest term, any research work could be viewed as a series of activities composed of five major steps or stages. They are as follows:

1) Definition of problem
2) Research design or plan
3) Collection of data
4) Analysis and interpretation
5) Report writing and communicating

The kinds of problems or specific activities required for each stage are shown in Figure 3.1.

(3) Questions that must be Raised

Underlying these steps of the research process are a host of questions to be raised and answered in corresponding with each step of the process. Full understanding of these questions is quite essential in order to carry out the proposed research project. There are different and hierarchical levels of questions, starting from the correct identification of management questions, translating them into research questions and moving on down to the questions that will be necessary for finalizing the research project.

Table 3.1 Outline of Research Plan

1. Statement of research objective

   Once paragraph clearly stating what you plan to do.

2. Specification of the research questions that must be analyzed, and indication of the scope of the proposed study and the limitations.

3. Indication of the research techniques which you plan to use in the proposed study such as;

   a) Field work

   b) Questionaire survey

   c) Statistical anlysis of the data

   d) Forecasting methods to be used

   etc.

4. Conceptual flowchart of the problems to be studied and defined work process on how these problems are to be analyzed by the proposed research techniques which are planned to be used.

5. Indication of the research schedule.

6. Organization of the research project team in which the major research roles are allocated among the researchers.

7. Preparation of time and cost budgets for the research project;

   a) Time budget should include an estimate of the man-hours required for the various research tasks of personnel such as project director, manager, senior and junior researchers, assistants etc.

   b) An estimate of the expected costs of the project should be indicated and classified by major expenditure item.

8. Method to be used for progress and cost control.

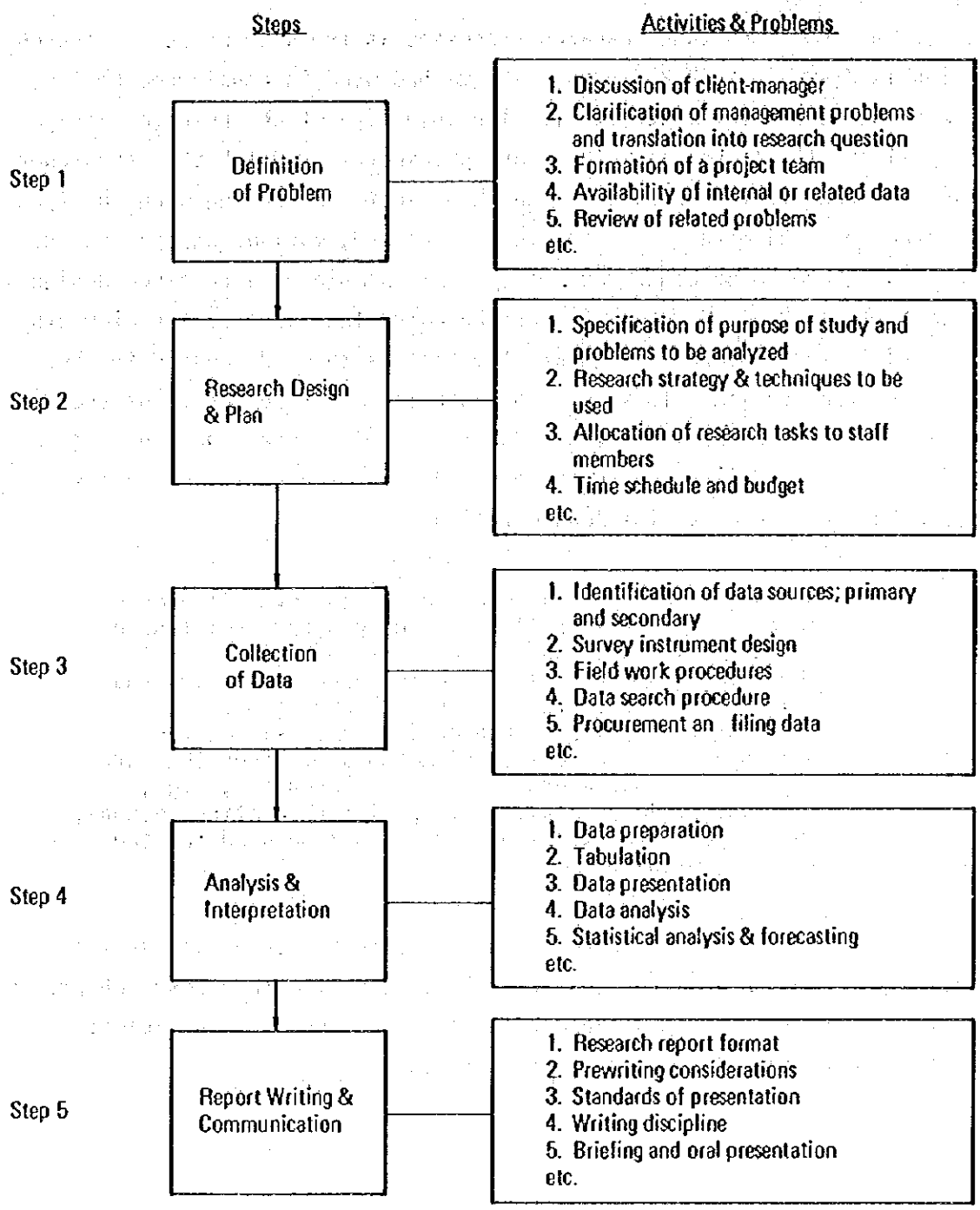

Fig. 3.1 Research Process

(4) Research Design

One of the most important research processes is the step where a research design is drawn in such a way that the method used is considered best suited to the problem under study. The objective of the research design is to spell out the technical methods and procedures by which the researcher wishes to execute the proposed research project. Depending upon the type of research problem that is going to be analyzed, various strategies and techniques have to be contrived. A typical example of a research design is shown in Table 3.2. However, it must be noted that some of the elements included in the research design are the same as those discussed in the research plan section. This is so because the major objective of the research plan is closely related to what kind of research design is drawn up. Nonetheless, regarding the research design, the following points should be taken into careful consideration:

1) A research plan is concerned about the overall process through which a specific research project is intended to be carried out, whereas a research design aims at the establishment of specific research techniques that will be used to solve the research questions.
2) Therefore, in any research design, emphasis must be placed upon the selection of methods of study that are regarded as most appropriate to the problems, e.g., the type of data, analytical and interpretating methods, theoretical framework, etc. that must be used for the specific problem.

In the first few years a researcher must acquire knowledge and skills necessary to design a method that will be best suited to a research problem. Trials and errors will be unavoidable before one acquires sufficient level of technical proficiency in this field.

Table 3.2 Outline of Major Elements of Research Design

1. Topic
2. Purpose of study
3. Problem analysis
   - 3.1 Summary of current knowledge partinent to topic
     - (1) Concepts, theories, principles, etc.
     - (2) Empirical findings
     - (3) Reports, descriptions etc.
     - (4) Suggested hypotheses
     - (5) Evaluation of current knowledge
     - (6) Existing and proposed solutions to operational problems
   - 3.2 Theoretical framework of study
     - (1) Concepts and theory to be used in study
     - (2) Assumptions of study-theoretical and empirical
   - 3.3 Detailed statement of the problem to be solved to achieve objectives of study
4. Research strategy to be used
5. Research techniques to be used
6. Methods of data analysis and forecasting
7. Format for reporting results of study
8. Time schedule and budget
9. Bibliography of material used in preparing research

3.3 Research Control

The research managers as well as actual research workers must see that proper control measures are adopted to assure that:

1) the quality of the research work itself is good enough to meet the technical requirements which are generally expected of any research work.
2) every step of the research work is progressing as originally planned and there will be no serious bottleneck or schedule delay in its work.
3) rules of cost accounting and auditing methods are properly observed so that there will be no cost overruns.

Usually, however, every research step tends to take much longer than was expected, and because of this the entire research schedule will be prolonged requiring a much longer time span than originally planned. Also it frequently happens that the data were erroneously collected or compiled, some miscalculations were made on the data, digits were misplaced, units of measurements were mistaken, etc. In view of this, the following step must be taken:

1) At the end of a major step in the research process, double checks should be made on data collection, processing and interpretation to assure that there will be no serious errors in analyzing the data and their results.
2) A progress control chart such as a Gantt chart should be used to ensure that the research schedule is being strictly observed and that it is progressing according to the plan.
3) Corrective measures should be taken in time when a serious problem arises during the research process.
4) Although CPM (Critical Path Method) may not be necessary for a research project of a relatively small scale, enough time allowance or lead time should be allocated to the critical points or problems. This is particularly necessary when problems arise in the acquisition of the data and statistical publications which is indispensable for the research work of the Economic Unit.
5) It is highly desirable that in order to establish smooth data processing operations within the Economic Unit, a research information management system should be contrived at the early stage of the organizational development of the Economic Unit.

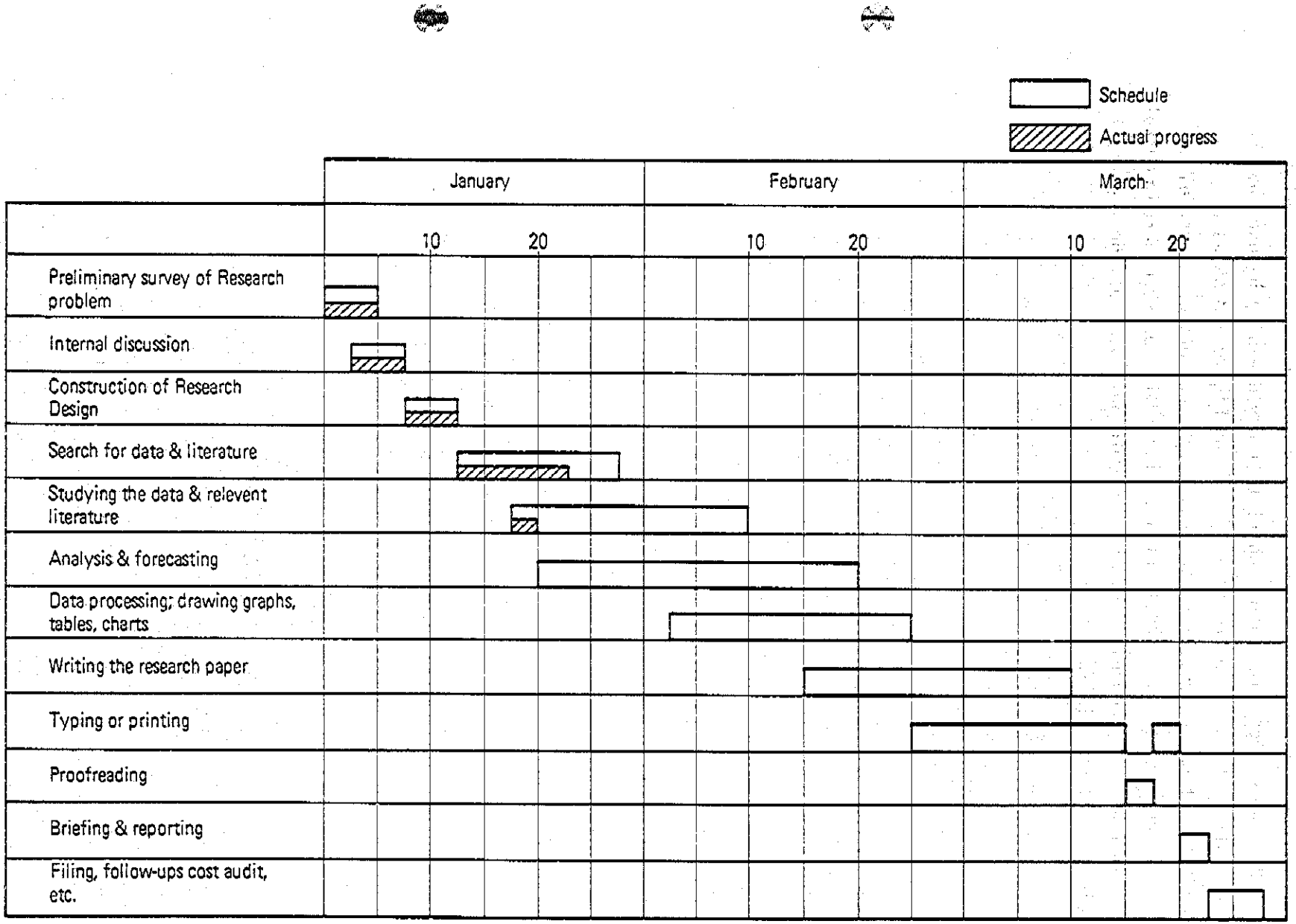

Fig. 3.2 Research Process Scheduling (an Example of Gantt Chart)

Figure 3.2 is an example of a Gantt chart that could easily be used by the research staff members of the Economic Unit and Figure 3.3 shows a research information management system that might be considered useful to the Economic Unit. For the purpose of assuring that proper research control problems will be well recognized by the Economic Unit some of the important checkpoints are listed in Table 3.2.

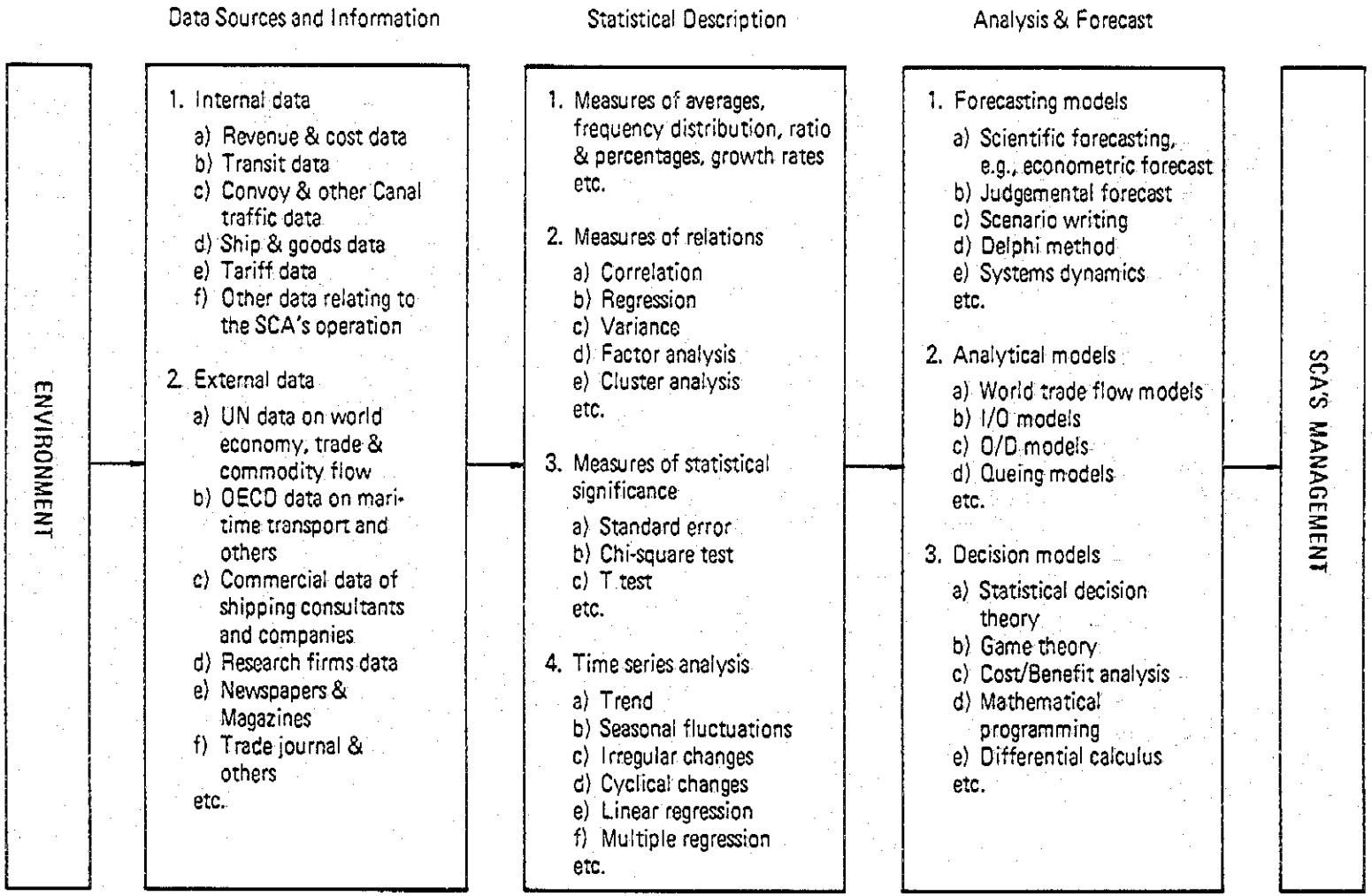

Fig. 3.3 Research Information Management System of the Economic Unit

Table 3.3 Requirements for Good Research

1. The purpose of the research, or the problem involved, should be clearly and sharply delineated in terms as unambiguous as possible.

   The statement of the research problem should include analysis into its simplest elements, its scope and limitations, and precise specifications of the meanings of all words significant to the research. In this regard, discussion with the client manager of the SCA should be deemed indispensable for clear definition of the problem. Failure of the researcher to do this adequately may raise legitimate doubts in the mind of readers as to whether the researcher has sufficient understanding of the problem.

2. The research procedures used should be described in sufficient detail to permit readers to evaluate the validity and reliability of the research.

   Excepting when secrecy is required involving the SCA's interest, research reports should reveal with candor the sources of data and the means by which they were obtained. Omission of significant procedural details make it difficult or impossible to estimate the validity and reliability of the research analysis and justifiably weakens the confidence of the readers in the E.U.'s researcher.

3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.

   Bibliographic searches should be as thorough and complete as possible. Sources of the data used in the research should be clearly indicated. Research findings should be cross-checked with the research results of other similar problems. Efforts should be made to minimize the influence of personal bias in selecting and recording data. When a sampling of a population is involved, the report should include evidence concerning the degree of representativeness of the sample. A questionaire survey should not be used when more reliable data is available from documentary sources.

4. The researcher should report, with complete frankness, flaws in procedural design and estimate their effect upon the findings.

   Clear indications should be made as to the absence of necessary data, use of substitute variables, assumptions of environmental conditions and cetris paribus (all things being equal) conditions, analytical and forecast methods used, etc. It must be noted that there are very few perfect designs and that some of the imperfection may have little effect upon the validity and reliability of the data. A competent researcher should be sensitive to the effects of imperfect designs and lack of necessary data.

5. Analysis of the data should be sufficiently adequate to reveal its significance; and the methods of analysis used should be appropriate.

   It must be understood that adequate analysis of the data is the most difficult phase of research for the novice, and the extent to which this criterion is met is frequently a good measure of the competence of the researcher. A careful check must be made as to selection of the data, the validity and reliability of the data, and the type of analytical methods to be used. The data should be classified in ways that assist the researcher to reach pertinent conclusions., e.g., the classification of data of independent and dependent variables, trend variables, etc. In addition when statistical methods are used, the probability of error should be estimated and the criteria of statistical significance applied.

6. Conslusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.

   Researchers should not broaden the basis of inductions by including personal experiences not subject to control to the controls under which the research data were gathered. Equally undesirable is frequent practice of drawing conclusions from study of a limited population and applying them universally. It is necessary that the conditions are specified by a researcher under which their conclusions are considered valid. It must be remembered that failure to do so weakens confidence in the research.

7. Greater confidence in the research is warranted if the researcher is experienced, has a good reputation in research, and is a person of integrity.

   It must be noted that overall reliability of the research is likely to be judged by who worked on it; how many years of experience he has as a researcher, what kind of the technical qualifications he has on the problem studied, and other qualifications. The credibility of the research depends in a large part upon the credibility of a person who wrote it. A good researcher uses a language that is restrained, clear and precise; assertions that are carefully drawn and hedged with appropriate reservations.; and an apparent effort to achieve the maximum objectivity.

CHAPTER 4 RESEARCH REPORT WRITING

4.1 Type of Report

(1) Oral or Written Report

(2) Informational or Research Report

The information report presents factual information in detail with little or no commentary, analysis, conclusions, or recommendations. The research report contains findings of facts, analysis of these facts, interpretations, conclusions and sometimes recommendations.

(3) Short Report

This is one of the most widely used. It generally consists of a title page and a text of less than five to ten pages. It is appropriate for examining a relatively simple problem. It is often used for progress reports and interim reports. This is a report type used for a problem of limited scope, requiring only limited items personnel and money and simple and straightforward methodologies.

(4) Letter Report

The letter report is often used when there is some single point to investigate. The letter tends to be informal and provide the conclusions called for plus just enough supporting data to make the conclusion clear and understandable and it usually presents nothing more than the gathering of information of the problem.

(5) Memorandum Report

The memorandum report is a version of a letter report but appropriate for more complex studies such as a preliminary investigation into the procedures for and feasibility of an engineering project. There is little uniformity in this report format but the following requirements must be met:

1) Tell the reader why this report is written; often it is in response to his request.

2) If the memorandum is in response to a request for information, remind the reader of the exact point raised, answer it, and then follow with any necessary details.
3) Write in a clear style, emphasizing brevity and directness.
4) If time permits, write it today and leave it for review tomorrow before sending it.
5) Attach detailed materials as an appendix where needed.

(6) Long Reports

Once a report exceeds a certain length going beyond ten pages, it typically takes on a more formal tone and is divided into clearly organized sections; a letter of transmittal, introduction, main body, conclusion, appendix, etc. The long reports could be divided into two varieties, the technical report and popular report, in terms of the audience for which it is written.

(7) The Technical Report

When a report is written for the audience of staff specialists, researchers and managers of the technical fields, the technical report format should be used taking into consideration the following:

1) They are interested in a full presentation and exploration of the data.
2) They prefer detailed findings.
3) They are concerned about the methods and techniques used and how they were carried out.
4) There should be a substantial technical appendix for methodological details, supporting evidence and other technical materials.

(8) The Popular Report

The popular report is designed for an audience of executives and other manager or nontechnical readers. For this type of report the following requirements must be met:

1) They are less concerned with methodological details but more interested in quickly learning the major findings and conclusions.

2) They are interested in applying the findings to management decisions.
3) The style in the popular report is designed to ecourage rapid reading and quick comprehension of major details.
4) More headlines, underlining, pictures, and graphs should be used. Sentences and paragraphs should be short.

4.2 Research Report Format

The research report could be divided into the following parts; introduction, main body and conclusion which are in turn subdivided into the following elements:

1) Prefactory pages
   a) Title pages
   b) Letters of transmittal and authorization
   c) Tables of contents, charts and illustrations
   d) Synopsis
2) Body of Report
   a) Introduction
   b) Findings
   c) Summary and conclusions
   d) Recommendations
   e) Appendix

These elements could be arranged and ordered in different ways but the most effective format to present the research is; after a brief introduction come the summaries, conclusions and recommendations, followed by the findings which support these conclusions. This format is the most useful because it provides the reader with the most critical information first and a conclusion. To the degree that he wishes to go further and study the findings in detail he may then do so. In the following, some examples are presented to indicate how the main body of the research report is differently arranged:

1. Introduction	1. Introduction
2. Statement of problem	2. Analysis of problems
3. Recommendations	3. Proposed solution
4. Supporting data	4. Anticipated results
	5. Recommendations

1. Introduction
2. Recommendation
3. Background information
4. Analysis of problem
5. Proposed solution
6. Conclusions

(1) Title and Contents

The title page should indicate the subject, date of the report, for whom prepared and by whom prepared. A table of contents is needed if the report is long or divided into a number of parts. If there are many charts, tables, or other exhibits, they should also be listed after the table of contents in a table of illustrations.

(2) Letter of Transmittal

If the research is for a specific client or manager, it is necessary that a letter of transmittal should be attached. Included in the letter should be some reference to the authorization for the project and any specific instructions or limitations that were placed on the study. The letter should state the purpose of the report and its scope. Sometimes a letter of authorization may precede the transmittal letter in the report.

(3) Synopsis or Summary

The purpose of the synopsis or summary is to allow the readers to understand essential features of the research. The following cautions are given in writing the synopsis:

1) The length should not exceed a couple of pages.
2) It must contain a sufficient statement of purpose, scope and method.
3) The synopsis should be devoted to the explanation of findings or results of the study.
4) The style of writing must place a premium on directness, conciseness, and condensation.

(4) Introduction

The introduction tells the reader what he has to know in order to understand the significance of the research findings that follow. Depending on the length and nature of the report, any or all of the following points must be treated:

1) Authorization for the report
2) Purpose of the report
3) Scope and limits of the report
4) Statement of the problem
5) Organization of the report
6) History of background of the subject
7) Method of study
8) Sources of information
9) Definition of terms
10) Acknowledgements
11) Summary of conclusions and recommendations

(5) Body of the Report

This is the largest section of the report. It should be an organized presentation of the results and not a clutter of charts and tables. Sufficient indications must be made to the empirical support for whatever conclusions are drawn. If reference is made to exhibits in the text, these exhibits should be placed on or immediately following the page where first reference is made to them. The tables and figures that are used in the body of the report should be simple in form and directed toward supporting some single point that is being made. Complex tables should be placed in the appendix. In writing the main body of the report the following should be kept in mind:

1) The materials presented must be arranged according to a logical order.
2) General problems must be stated and analyzed first, followed by the specifics.
3) Analysis and description of the past trends and conditions must be made first and followed by the explanation of the present state of affairs.
4) Results of forecasting analysis should be separately treated, and detailed explanation must be made as to how the analysis was made.
5) Discussion should be presented strictly in accordance with a certain theoretical frame of reference.
6) Personal opinions may be expressed only when they were justified by empirical evidence, data and findings.
7) There is a need to be discriminating in the findings that one reports. Included in the report are materials important to the development of the reader's understanding of the problem and research.

(6) Conclusions

The conclusions are the major output of the research in which answers must be given to the problems raised in the study. They are also the summary restatement of the research findings. All of these statements should be coded or marked in some way so that they refer to pages or tables in the main body of the report. In the conclusion the following should be included:

1) Summary of purpose and main points
2) Significance of the research findings
3) Inferences to be drawn from the findings
4) Recommendations

(7) Recommendations

The recommendations are typically brief statements of a limited number of suggestions for further consideration. In many studies there will be no recommendations because of the nature of the study; it may also be that the researcher's function in a given study may not call for him to make recommendations. When recommendations are made, the following cautions should be made.

1) They should include statements suggesting a concrete course of action to the readers.
2) Enough supporting data and reasoning should be presented.
3) Merits and demerits of the possible alternatives should be clearly indicated.

(8) Appendix

The appendix should include complex tables, statistical data, supporting documents, detailed descriptions of the methodology, and any other technical materials and evidence that may be important as backup detail for the research report. The appendix should be prepared for the readers who wish to know more about the technical details of the study. It must also not be forgotten that a bibliography will be attached completely concerning sources of the data and books referred to in the study.

4.3 Popular Report Format

As mentioned before, the popular report is designed for an audience of executives and other nontechnical readers, and therefore care must be made to

enable the readers to quickly understand the major findings of the research. It should be written in nontechnical terms. A typical outline of a popular report might be as follows:

(1) Title Page

This should indicate the subject, data of the report, for whom prepared and by whom prepared.

(2) Table of Contents

It is needed if the report is more than a few pages long.

(3) Objectives of the Study

A brief summary that explains the reasons that brought about the study, including any hypothesis to be tested or research questions to be answered.

(4) Methodology

A brief nontechnical statement of the methods used, the kind and nature of data, the limitations of the study and methods, and procedures through which the study was carried out. In all cases these should be stated in nontechnical terms. Any supporting data should go into an appendix.

(5) Conclusions and Recommendations

Highlights of the major findings are presented here in summary form. If recommendations are called for they should also be placed here.

(6) Findings

This should be a simplified presentation of the basic research findings of the study. Statistical data should be presented in charts or simple tables. Commentary on the specific findings should be briefly given.

(7) Appendix

The size of the appendix should be much smaller than in the technical report. A brief indication should be given to reference materials, bibliography, methods used in the study, etc.

Table 4.1 Reminders of Report Writing

1. Questions that should be raised before beginning to write;
   a) What is the purpose of this report?
   b) Who will read the report?
   c) How much do readers know about the technical problems?
   d) What are the conditions and limitations under which a report must be written?
   e) How will the report be used?

2. Writing the outline of the report

   Once the researcher has made his first analysis of the data, drawn his tentative conclusions, and performed statistical and other necessary analysis, an outline of the report should be written starting from the major topic and breaking down to subtopic, minor subtopic, further detail, etc.

3. Avoidance of Essay Style
   a) Research reports should be written in such a way that information is conveyed, stripped of multiple meanings and elegant allusion.
   b) A report should be clearly organized so that readers can have apparent progress in theme development.
   c) A report must communicate in such a way that the reader can easily understand what is wirrten.

4. Start drafting ideas as soon as possible

   Do not wait until you have gathered all your material before starting to write but begin drafting your ideas as soon as some portion of the topic appears to hang together in your mind.

5. Other writing techniques
   a) Do not be afraid of writing down something that might be changed later.
   b) Do not hesitate to write in any order those sections of the paper that seem to have grown ripe in your mind.
   c) Once you start writing you must keep it going. Resist the temptation to try to answer the questions newly arisen in you mind. The saving in time and momentum is incalculable.
   d) When you get stuck in the middle of a stretch of writing, reread you last two or three pages and try to see if continuity of thought will extend in some other way.