CHAPTER 12

PROJECT COST ESTIMATION

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12.1 General

Project cost was estimated applying the results of the preliminary engineering design, work item quantities, and the results on construction method and operation and maintenance for the OCH described in the other chapters. Project cost in this chapter consists of the following items:

- **Project Cost**
  - Construction
  - Engineering Services (detailed design/ tender assistance/supervision services)
  - Land Acquisition and Resettlement
- **Operation and Maintenance Cost**
  - Utility: Electricity, Water Supply
  - Overlay

The basic premises in estimating project cost are as follows:

1) All construction work will be executed by private contractor(s).

2) The unit cost of each cost component was determined based on the economic conditions prevailing in 1999 (Rs 1.0 = 1.6 Yen).

3) The engineering services consist of detailed engineering design and construction supervision and has been estimated at 8% of construction cost. Tendering assistance will be required at the time of tender and it is estimated that this will be equivalent to 2% of construction cost.

4) Land acquisition and resettlement cost were worked out in the EIA on the basis of market prices estimated by a land assessor.

5) Physical contingency is estimated to be 10% of the total for construction cost, land acquisition and resettlement cost, and engineering services cost (including supervisory services).

6) Currency

   Exchange Rate: RS. 1= 1.6 YEN (December 1999)

7) Taxation

(a) Civil Works:

- GST	12.50%
- Defense levy on imports	6.00%
- Tax on civil works (GST/ CD/ DL)	18.90%

(a) Consulting Services GST only 12.50%

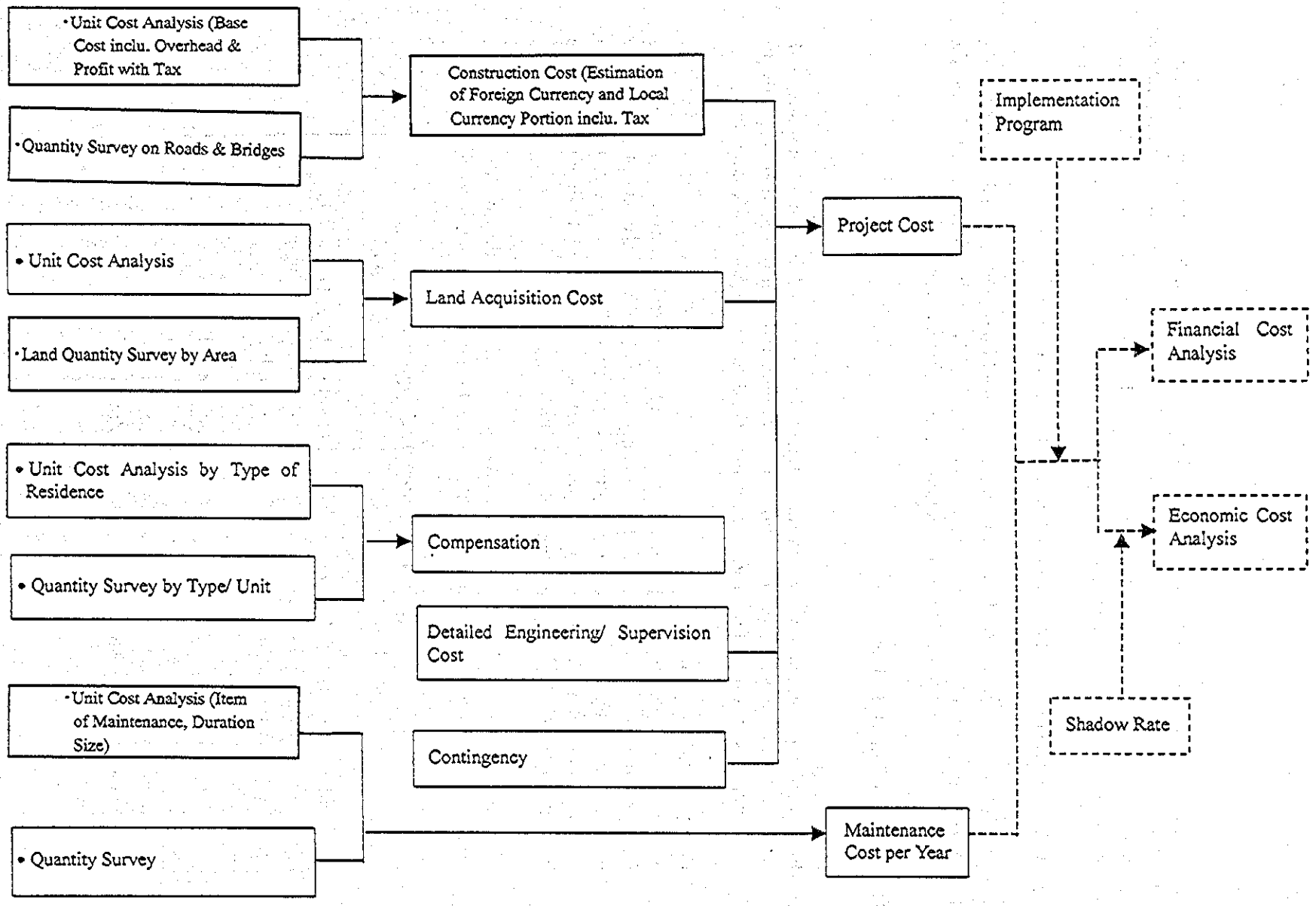

Fig. 12.1 Procedure for Cost Estimation

12.2 Procurements

(1) Labor Force

General road work in Sri Lanka is mostly carried out by local contractors. There is much labor with skills in civil works, except when specific skills in fields like pre-stressed concrete is required. There are several post-tensioned concrete bridges in this project. Some local construction firms can undertake such work.

(2) Supply of Machinery and Materials for Bridge Construction

It is difficult to procure in Sri Lanka the necessary machinery and materials to ensure the quality required for bridges. Also, since domestic supply is insufficient, much of the machinery and materials for bridge construction will have to be imported.

1) Construction Materials

(a) Cement

In Sri Lanka, cement is produced by the Puttalam Company and the Galle Company, with a relatively low annual output of approx. 500,000 tons and approx. 250,000, respectively. This supply is insufficient to meet home demand and cement is constantly imported.

(b) Ready-Mixed Concrete

There are eight companies that can produce and supply ready-mixed concrete in the Colombo region, as shown in Tab.12.1. Each manufacture has only one plant and few mixer trucks. Therefore, OCH may require its own plant for the supply of ready-mixed concrete at the sites for bridge construction. It may be also necessary to import a concrete batch plant, which is difficult to obtain in Sri Lanka.

There are a few examples of post-tensioned concrete bridges like the one for this project. Some local construction firms can undertake related general construction work.

Tab. 12.1 Concrete Suppliers

Suppliers	Address
1. Sanken Lanka (PVT) Ltd	Colombo 14 & Peliyagoda
2. Devco Showa (PVT) Ltd	Nage Road, Peliyadoga
3. Informax Construction (PVT) Ltd	Conlombo 10
4. Tudawa Srothers	Colombo 5
5. Sunbee Ready Mixed	Battaramulla
6. Maga Engineering	Gothatuwa
7. International Construction Consortium	Bekundara
8. Keangnam Ready Mixed	Malabe

(c) Reinforcing Bar

The Ceylon Steel Company produces 50,000 tons of reinforcing bars a year, most of which are 5.5 mm and 6.0 mm in diameter. The firm does not manufacture reinforcing bars for engineering work. In addition, it is unable to satisfy domestic demand and supplies from other countries are being considered. It is advisable that if bars are to be obtained from other countries, that the stability of supply, quality, and price fluctuations be taken into consideration.

(d) Crushed Stone

Crushed rock quarries had been introduced at the time of the Study's Progress Report in March 1999. The crushed stone obtainable from these quarries will not be able to satisfy the requirements of the OCH. Therefore, it is also necessary to consider using crushed stone excavated from the construction sites for the road base or concrete aggregate material. On the other hand, procurement will be more effective in controlling fluctuations in construction cost. More efficient methods shall be considered at the detailed design stage.

(e) Sand

Sand is available from the seashore around northern Colombo. However, it must be desalinized when used for mixing concrete because of the alkali reaction of concrete. Sand washing work shall be required for admixing concrete.

(f) Filling and Sub-grade Materials

Hilly areas near the access road are mostly rock and it is difficult to obtain filling material from there. It is necessary to obtain and/or purchase this from private landowners.

(g) Asphalt (bituminous materials)

There is no private company, that produces and supplies bituminous material, and the government-owned Ceylon Petroleum Corporation is the sole company in this field. To obtain asphalt for OCH construction, purchases will have to be made from this corporation. However, hot mixed asphalt concrete can be purchased from the asphalt plant owned by RC & DC near Colombo City. Therefore, all of the asphalt materials for the OCH can be produced in Sri Lanka, except for specialized bituminous that shall be imported from a third country such as Singapore.

Private companies that can manufacture and supply asphalt concrete in the Colombo area are shown in Tab. 12.2. Should the paving work for the OCH exceed the capacity of these companies, it may be necessary to build a plant for the OCH.

Tab.12.2 Asphalt Suppliers

Name of supplier	Address
International Construction Consortium Ltd.	MADAOATHA (No.291 Modara Street Colombo 15)
Shaken Engineering (PVT) Ltd.	PAPPLIYAWELA (401-8-1/1 Gall Road Colombo 4)

(h) Steel (reinforcement and steel materials)

Concerning reinforcement, as is the case in cement, domestic production is insufficient to meet demand. Reinforcements of 25 mm or more in diameter or 6 m or more in length must be imported. Most imports will be BS-based products from South Africa and Singapore. Other steel materials, excluding special and large steel materials, are available in Sri Lanka. PC steel and steel sheet piles used in large quantities for bridge construction work will all be imported, mostly from South Africa, Singapore, and Thailand. Also, steel H-shaped beams and sheet piles are to be imported because they are not produced domestically.

(i) Foreign and Local Currency Portions for Construction Materials

The plan for procuring other construction materials, including those mentioned above, is shown in Tab. 12.3 below and is divided into foreign and domestic currency portions.

Tab. 12.3 Proportions of Local and Foreign Currency for Procurements

Items		Currency Portion	
		Foreign	Local
a.	Concrete produced by batches plant including material	40%	60%
b.	All equipment and plants for road construction	40%	60%
c.	Asphalt (Bituminous, coat) for pavement material including production costs by plants	30%	70%
d.	Reinforcing bar (deformed steel bar ϕ 10~51 mm)	70%	30%
e.	PC beam including pre-stressed tendon	100%	0%
f.	Raw materials such as sand, aggregate, rock, and embankment material are locally available.	0%	100%
g.	Concrete products such as pipes, piles	50%	50%
h.	Form work (timber, steel including manufacturing)	60%	40%
i.	Frame support/ scaffolding work	80%	20%
j.	Labor (including expatriate expert labor)	10%	90%
k.	Fuel (gasoline, diesel)	100%	0%

(3) Construction Machinery

Construction machinery includes those possessed by both government agencies and private companies. Private contractors generally use their own machinery, while some companies lease machinery. Since nearly 80% of this machinery will be required, thorough maintenance is necessary to avoid trouble with OCH construction work.

In particular, since companies do not have a sufficient amount of stock for machine parts, machine failure can result in work being suspended for a few days, or a few weeks, or a few months in worst case scenarios while waiting for the import of necessary parts.

1) Construction Machinery and Plant (ready-mixed concrete, asphalt) Owned by Government Agencies

Construction machinery possessed by government agencies is shown in Tab. 12.4. Though this machinery cannot be leased to private construction company, leases may be granted as an exceptional in the case of a project coming under the control of the agency concerned.

Tab. 12.4 Construction Machinery Possessed by Government Agencies (1998)

Machinery	Specifications/ Performance	Quantity
Bulldozer	50HP-140HP	48
Scraper	less 10m3	1
Motor grader	3m – 4m	37
Wheel loader	1.5m3 – 2.0m3	23
Drilling machine		1
Compressor	350C.F.H	33
Pilling machine		3
Vibration roller	10 ton or less	2
Dump truck	10 ton or less	220
Truck crane	10 ton or less	20

2) Construction Machinery and Plant which can be Procured or Leased in Sri Lanka

Almost all conventional construction machinery is procurable within Sri Lanka, but quantity is limited and the working day ratio is extremely low. Considerable time is also necessary in order to obtain replacement parts. Given this background, it is necessary to introduce machinery into Sri Lanka while preparing a sufficient quantity of replacement parts for busy construction periods. Construction machinery that can be procured and leased in Sri Lanka is shown in Tab. 12.5. However, the amount of heavy machinery (crawler cranes, etc.) available for the OCH is small.

Tab.12.5 List of Construction Machinery Procurable in Sri Lanka (1998)

Machinery	Specifications/ Performance	Quantity
Backhoe	0.5 m^3 less	6
	1.5 m^3 - 1.0 m^3	44
	1.1 m^3 - 1.5 m^3	7
	1.5 m^3 and more	3
Bulldozer	50 H.P - 100 H.P	143
	101 H.P - 139 H.P	88
	140 H.P - 179 H.P	25
	180 H.P - 250 H.P	41
	251 H.P - 350 H.P	32
	350 H.P and more	17
Motor grader	3.0 m	13
	3.5 m	67
	4.5 m	6
Wheel loader	1.5m^3 and less	14
	1.5 m^3 - 2.0 m^3	70
	2.0 m^3 - 2.5 m^3	33
	2.5 m^3 and more	12
Tire backhoe	1.0 m^3 and less	68
Compressor	175 C.F.M	40
	175 – 350 C.F.M	42
	350 C.F.M and more	13
Vibration roller	5 ton and less	8
	5 ton – 10 ton	10
Dump truck	5 ton and less	55
	5 ton – 7 ton	147
	7 ton – 10 ton	97
	10 ton – 16 ton	120
	16 ton and more	35
Asphalt plant	50 ton/ h and less	1
	50 ton/ h and more	3
Distributor	1,000 litter	19
	4,000 litter	4
Trick crane	10 ton and less	2
	10 ton and more	24
Crawler crane	37 ton	3
	80 ton	2
Stone crusher	20 ton/ h and less	1
	20 ton/ h – 50 ton/ h	30
	50 ton/ h – 100 ton/ h	11
	100 ton/ h and more	4

3) Construction Machinery Possessed by Foreign Contractors (India, South-Eastern Asia, Europe, etc.)

Construction projects have or are being carried out by Japanese and foreign contractors here in Sri Lanka. Tab. 12.6 shows the principal machinery possessed by these foreign companies. However, most of this machinery is for individual projects and will be shipped from Sri Lanka once these projects are completed.

Tab. 12.6 Construction Machinery Possessed by Foreign Companies (1998)

	Name of company	Type of machinery	Specifications/ Performance
1 Japanese Company	Kajima Corp.	Truck crane Vibration hammer	90 ton 25 ton 5 ton
	Joint venture of Kumagai, Hazama, and Kajima	Dump truck Truck crane	4 ton 45 ton
	Joint venture of Goyou and Wakachiku	Dump truck Backhoe Truck crane Crawler crane Bulldozer Wheel loader Compressor Generator	10.0 ton and less 0.35 m^3 60 ton 100 ton/ 50 ton 15 ton 1.4 m^3 7.0 m^3/ min. 100 kva/ 50 kva
2 Korean Company	Keangnam Company	Backhoe Bulldozer Wheel loader Motor grader Tire backhoe Compressor Vibration roller Dump truck Asphalt plant Asphalt finisher Distributor	0.5 m^3/ 1.0 m^3 100 H.P-250H.P 2.0 m^3 3.0 m/ 3.5 m 1.0 m^3 7.0 m^3 10 ton 5 ton - 10 ton 100 ton/ h 20 ton/ h 1,000 liter

4) Construction Machinery to be Procured Outside of Sri Lanka

Special construction machinery is difficult to procure in Sri Lanka. Tab. 12.7 shows the machinery to be imported into Sri Lanka to ensure smooth implementation of the construction work for OCH.

Tab. 12.7 Machinery to be Imported

Name of construction machinery	Specifications/ Capacity
Truck crane	45 ton
Diesel hammer	45
Vibro-hammer	90 kw
Generator	250 kva
Compressor	11 m^3
Earth auger machine	1,000 m^3 - 1,200 m^3
Reverse excavation machine	S320
Grouting machine	
Crawler drill	38mm, 50mm
Drilling machine for blasting	38mm, 50mm

5) Maintenance of Construction Machinery

Maintenance of construction machinery is extremely important and one of factors on which the success of the OCH project is dependent. Fuel and oil/ grease materials will all be imported into Sri Lanka. For oil/grease, it may be necessary to import some special types for certain cases. Machine components must be kept in stock on site after confirmation of the model of a machine regardless of whether the machinery is owned by a local contractor, controlled by a project contractor, or is leased.

(4) Local Contractors

Contractors that will to be engaged in the road and bridge construction work for the OCH will include government and private organizations consisting of research, design, and construction organizations. Competent organizations registered by the Road Development Auhtority (RDA) are as follows:

(a) Government-Owned Companies
State Development & Construction Corporation
State Engineering Corporation

(b) Affiliated Companies to RDA
Road Construction & Development Co.

(c) Private Companies
CML Edwars Construction Co., Ltd.
Samuel Sons & Co., Ltd.
International Construction Consortium Ltd.
Maga Engineering (PVT) Ltd.
Tudawe Brothers Ltd.
Dharmasena & Company
Daya Construction (PVT) Ltd.
Keangnam Companys Ltd.
Walker Sons & Co., Engineers (PVT) LTD.

(5) Access of Construction Materials and Machinery to the Site

Construction materials and machinery will be transported to site mainly by truck. Materials and machinery difficult to procure in Sri Lanka will either be unloaded at Colombo Port when imported by sea or at Katunayaka International Airport when imported by air and then transported to site.

12.3 Construction Quantities

Project costs have been produced on the basis of construction items described below. Quantities have been obtained from Preliminary Design Drawings based on 1/5,000 topographical maps.

12.4 Construction Cost

12.4.1 Unit Cost Analysis

The unit costs for each construction item have been estimated based on the Highway Schedule of Rate of the RDA for 1999, which is updated from Interim Reports, current contract prices, and unit prices equated from market prices or local practice for relevant projects.

Tab.12.8 Lump Sum Items

	Items	Ratio
1	Unit rates shall include overhead and a profit component.	Road Work: 10% Structure Work:15%
2	Contingencies for project cost are assumed to be 10% of the cost for construction / engineering	Physical Contingency: 10%
3	Engineering costs, such as detailed design, tender assistance and supervision work, are assumed to be10% of construction costs	Engineering Service: 8% Tender Assistance: 2%

12.4.2 Unit Costs of Construction Works

The unit costs of construction for chief work items have been estimated based on labor costs, material costs, equipment cost, overhead, and profit. The unit cost has been compared with current bid prices and adjusted as required to obtain the most realistic prices.

(1) Unit Cost of Labor

Tab. 12.9 shows the unit cost of labor referred to in the construction cost estimate, which includes such allowances as social benefits, insurance, etc, and are based on an eight-hour work day.

Tab. 12.9 Unit Rate of Labor

Classification	Unit Rate (Rs)
Senior Field Engineer	30,000/ month
Junior Field Engineer	15,000/ month
Foreman	400/ day
Driver	300/ day
Equipment Operator	300/ day
Skilled Labor	300/ day
Unskilled Labor	200/ day

(2) Unit Cost of Materials

Tab. 12.10 shows the unit costs of major construction materials. The cost for imported materials is based on the CIF for Colombo, including port handling and clearance charges and import duties. The cost of local materials is based on the market prices in the Colombo area.

Tab. 12.10 Unit Rate of Major Materials

Description	Unit	Unit Rate (Rs)
Portland Cement	ton	5,300
Asphalt	ton	11,600
Reinforcing Steel	ton	32,000
Gasoline	liter	43
Diesel	liter	13
Fine Aggregate	cu.m	460
Coarse Aggregate	cu.m	1,000

(3) Unit Rate of Equipment

Tab. 12.11 shows the unit rate for major construction equipment. The costs of imported equipment are based on the CIF for Colombo, including port handling and clearance charges and import duties.

Tab. 12.11 Unit Rate of Major Equipment

Equipment	Capacity	Unit Rate (Rs)
Dump truck	4 ton	420
Dump truck	15 ton	930
Truck crane	25 ton	3,500
Crawled crane	35 ton	2,200
Concrete pump truck	80 m^3/ hr	2,300
Truck mixer	6 m^3	1,100
Back hoe	0.6 m^3	1,200
Motor grader	3.1 m	1,300
Macadam road roller	8-12 ton	700
Asphalt finisher	2.4-5.0 m	2,350
Asphalt mixing plant	40 t/ hr	2,500
Concrete mixing plant	30 m^3/ hr	2,500

(4) Overhead

Overhead is estimated as 10% of the sum for road work and 15% of the sum for structure work.

(5) Unit Cost for Major Construction Work Items

Tab. 12.12 shows unit costs for major construction work items based on the unit cost mentioned above.

Tab. 12.12 Unit Cost for Major Construction Work Items

	Item	Unit	Unit Cost (Rs)
1.	Earthwork		
	Cutting (cutting, loading)	m3	140.00
	Embankment (cutting & filling)	m3	84.96
	Embankment (borrow, loading, spreading, compaction)	m3	268.10
	Embankment (spreading, compaction)	m3	71.70
	Foundation stabilizer (sand blanket t = 100 cm)	m2	500.00
	Slope protection (turfing)	m2	52.10
2.	Road Work		
	Wearing course (asphalt con, 40 mm including tack coat)	m2	287.10
	Binder course (asphalt con, 60 mm including prime coat)	m2	356.62
	Base course 200 mm	m2	341.94
	Subbase course 200 mm	m2	66.88
3.	Bridge Work		
	Connected continuous		
	Pre-tensioned girder (L = 83.0 = 20.5 + 2 @ 21.0 + 20.5)	m2	69,336.00
	Simple pre-tensioned girder (L = 22.0 m)	m2	110,992.00
	Simple pre-tensioned T girder (L = 30.0 m)	m2	96,924.00
	Simple post-tensioned box girder (L = 40.0 m)	m2	95,986.00
4.	Box Culvert (traffic; A: inner section)		
	UCX W8.0xH6.0 m (A=48m2)	m	1,440,000.00
	UCX W6.0xH6.0 m (A=36m2)	m	1,080,000.00
	UCX W6.0xH5.0 m (A=30m2)	m	900,000.00
	UCX W5.0xH5.0 m (A=25m2)	m	750,000.00
	UCX W6.0xH3.0 m (A=18m2)	m	540,000.00
	UCX W5.0xH3.0 m (A=15m2)	m	450,000.00
	UCX W4.0xH2.0 m (A=8m2)	m	240,000.00
	UCX W6.0xH0.5 m (A=3m2)	m	90,000.00
5.	Drainage Work		
	(1)PC f^3D1500 mm	m	37,500.00
	(2)Box Culvert (A: inner section)		
	DCX W10.0xH4.0m(A=40m2)	m	1,380,000.00
	DCX W6.0xH4.0m(A=24m2)	m	828,000.00
	DCX W7.0xH3.0m(A=21m2)	m	724,500.00
	DCX W5.0xH3.0m(A=15m2)	m	517,500.00
	DCX W4.0xH2.0m(A=8m2)	m	276,000.00
	DCX W3.0xH2.0m(A=6m2)	m	207,000.00

6.	Miscellaneous		
	Temporary road	Ls.	(Earth Works+Bridge Works)×0.03
	Temporary construction facilities	Ls.	(Earth Works+Bridge Works)×0.01
	Traffic sign boards and safety control facilities	m	1,030.00
	Traffic illumination	Nos.	450,000.00
	Access control facility (guard rail)	m	4,000.00
	Lane marking	m	525.00
	Fencing and km posts	m	4,000.00
	Traffic signal	Nos.	6,000,000.00
	Roadside planting	m	190.00
	Pipe works for communication cable	m	510.00

12.4.3 Estimated Construction Cost

A summary of the estimated construction cost for each part of the OCH and for each construction stage is shown in Tab. 12.13. Note that project cost for the OCH excludes Part 1, which will be constructed by the Southern Highway Project. However, for the purposes of economic/financial evaluation, Part 1 shall be taken into consideration in the calculation of benefits and costs.

Tab.12.13 Summary of Estimated Construction Cost (including Contingency) in 1999 Prices (million Rs.)

	Part	Initial (4 lanes)			Final (6 lanes)		
		Construction	Tax & Duty	Total	Construction	Tax & Duty	Total
Southern Highway Project	1	3,814.2	1,054.0	4,868.2	4,060.1	1,121.5	5,181.6
OCH Project	2	4,198.2	1,161.2	5,359.4	4,481.4	1,239.1	5,720.5
	3	2,674.1	722.2	3,396.3	2,813.3	760.3	3,573.6
	4 *	1,707.1	462.2	2,169.3	1,707.1	462.2	2,169.3
	Total	8,579.4	2,345.6	10,925.0	9,001.8	2,461.6	11,463.4

* 4 lanes for final stage

12.4.4 Estimated Engineering Service (E/S) Cost

Tab.12.14 Summary of Estimated E/S Cost (including Contingency) in 1999 Prices (million Rs.)

	Part	Initial (4 lanes)			Final (6 lanes)		
		E/S	Tax & Duty	Total	E/S	Tax & Duty	Total
Southern Highway Project	1	381.4	79.2	460.6	406.0	84.3	490.3
OCH Project	2	419.8	87.3	507.1	448.1	93.1	541.2
	3	267.4	54.0	321.4	281.3	56.8	338.1
	4 *	170.7	34.6	205.3	170.7	34.6	205.3
	Total	857.9	175.9	1,033.8	900.1	184.5	1,084.6

* 4 lanes for final stage

12.5 Land Acquisition and Resettlement Cost

Land acquisition and resettlement costs have been estimated based on the preliminary design(PD) in this report. The unit costs for house demolition and land acquisition have been extracted from the EIA report.

12.5.1 Demolition Cost

Tab.12.15 Demolition Cost of Residential Buildings

Type of House	Ave. Flr. Area (sq.ft)	No. of Houses	Value per sq.ft (Rs.)	Cost (Rs.)
Shanties	300	28	250	2,100,000
Single Storey – small	500		500	
Single Storey – medium	900	817	850	625,005,000
Single Storey – large	1,500		850	
Double Storey	2,500		950	
Under Construction – small	500		500	
Under Construction – medium	900		850	
Total		845		627,105,000

Tab.12.16 Floor Area of Non-Residential Structures to be Demolished

Type	Number	Total Flr. Area (sq.ft)	Value per sq.ft (Rs.)	Cost (Rs.)
Industries	9	75,000	780	58,500,000
Business/shops (small)	31	18,600	780	14,508,000
Business/shops (large)	10	40,000	780	31,200,000
Warehouses	7	35,000	780	27,300,000
Container Yards	1	4,000	780	3,120,000
Workshops	4	8,550	780	6,669,000
Temples	0	0	780	0
Schools	0	0	780	0
Total	62	181,150		141,297,000

In the preliminary design, the alignment is located so as not to disturb temples and schools.

Total Cost (Part1~Part4) : 768,402,000 (Rs.)

Tab.12.17 Demolition Cost (million Rs.)

Part 1 (Southern Highway)	Project Cost				Grand Total
	Part 2	Part 3	Part 4	Total	
244.7	299.7	121.9	102.3	523.9	768.6

12.5.2 Land Acquisition Cost

Tab. 12.18 Agricultural Land Area to be Acquired by the Project

Crop	Area (ha)	Percentage	Main DS Divisions under Cultivation
Rubber	23.33	8.87	Homagama, Bandaragama
Coconut(*1)	41.56	15.80	Bandaragama, Biyagama
Paddy(*1)	90.99	34.59	Homagama, Kaduwela, Maharagama
Garden(*2)	107.17	40.74	Biyagama, Kaduwela, Homagama, Bandaragama, Maharagama
Total	263.05	100.00	

(*1) Including Residential & Commercial Area (36.15ha)
(*2) Including Residential & Commercial Area (27.27ha)

Tab.12.19 Summary of Land Acquisition Costs (Part1~Part4)

Land Use Type	Land Area (ha)	Cost (Rs.) (*)
Residential & Commercial	63.42	209,744,858
Home Gardens & Market Gardens	80.10	295,532,024
Other Agricultural Land-Rubber, Coconut & Paddy	119.50	180,023,745
Scrub, Marshland, Barren & Forest	56.68	0.00
Total	319.70	685,300,627

(*) Quoted from EIA Report Tab.6.15.6.3

Tab.12.20 Land Acquisition Cost (Rs.)

Part 1 (Southern Highway)	Part 2	Part 3	Part 4	Total	Grand Total
218.2	267.2	108.7	91.2	467.1	685.3

12.5.3 Resettlement Cost

The affected population has been estimated based on the OCH Socio-Economic Survey (SES) and resettlement costing based on the Southern Highway Project. Costs do not include resettlement development costs.

Tab.12.21 Compensation Package

Type of House	No. of Houses	Unit Cost (Rs.)	Cost (Rs.)
Residential Building	817		151,104,886
Squatter	28	10,000	280,000
Total	845		151,384,886

Tab.12.22 Shifting Cost for Relocation

Type of House	No. of Houses	Unit Cost (Rs.)	Cost (Rs.)
Residential Building	817	8,500	6,944,500
Commercial Establishment	62	24,000	1,488,000
Squatter	28	3,000	84,000
Total	907		8,516,500

Tab.12.23 Cash Assistance for Income Restoration

Type	No. of Person	Unit Cost (Rs.)	Cost (Rs.)
Informal Sector(*1)	250	15,000	3,750,000
Registered Business(*1)	54	45,000	2,430,000
Total	304		6,180,000

(*1) These figures are calculated for the OCH right-of-way based on the SES.

Tab.12.24 Loss of Employment due to Project ROW

Type	No. of Person	Unit Cost (Rs.)	Cost (Rs.)
Casual Labourers(*2)	235	15,000	3,525,000
Farmers(*3)	26	15,000	390,000
Total	261		3,915,000

(*2) Quoting the same ratio with (*1) 0.639

(*3) These figures are calculated for the OCH right-of-way based on the SES.

Total Cost (Part1~Part4) :169,996,386 (Rs.)

Tab.12.25 Resettlement Cost (million Rs.)

Part 1 (Southern Highway)	Project Cost				Grand Total
	Part 2	Part 3	Part 4	Total	
54.1	66.2	26.9	22.6	115.7	169.8

12.5.4 Relocation Cost for High Tension Tower

Tab.12.26 below estimates the relocation cost for high-tension towers.

Tab. 12.26 Number of High-Tension Towers to be Relocated (million Rs.)

	Part	Station	Quantity	Unit Cost (including overhead 10.0%)	Cost	Replacement of parts	Total
Southern Highway Project	1	280+0.0	1	16.5	16.5	1.85	18.35
		391+0.0	1		16.5	1.85	18.35
		431+0.0	1		16.5	1.85	18.35
	Total		3		49.5	5.54	55.04
OCH Project	2	134+0.0	1		16.5	1.85	18.35
	3	41+0.0	1		16.5	1.85	18.35
	4	438+50.0	1		16.5	1.85	18.35
	Total		3		49.5	5.54	55.04

12.5.5 Total Cost for Land Acquisition and Resettlement Cost

Tab.12.27 Summary of Estimated Land Acquisition and Resettlement Cost (million Rs.)

Description	Part 1 (Southern Highway project)	OCH Project			
		Part 2	Part 3	Part 4	Total
(1)Demolition	244.7	299.7	121.9	102.3	523.9
(2)Land Acquisition	218.2	267.2	108.7	91.2	467.1
(3)Resettlement	54.1	66.2	26.9	22.6	115.7
(4)Removal of High Tension tower	55.0	18.3	18.3	18.3	55.0
Total	572.0	651.4	275.8	234.4	1,161.6

12.6 Estimated Project Cost

12.6.1 Estimated Project Cost in the Initial and Final Improvement Stages

The summary of the project cost in 1999 prices is shown in Tab.12.28, with the foreign and local currency portions shown in Tab.12.29. Project cost is expressed in terms of financial cost and is divided into the investment cost in the initial and final stages for each part of the OCH project.

Tab.12.28 Summary of Project Cost in 1999 Prices (million Rs.)

Part 1 (Southern Highway)

Description	Initial (4 lanes)			Final (6 lanes)		
	Cost	Tax & Duty	Total	Cost	Tax & Duty	Total
(1)Construction (including Contingency)	3,814.2	1,054.0	4,868.2	4,060.1	1,121.5	5,181.6
(2)Engineering Service	381.4	79.2	460.6	406.0	84.3	490.3
(3)Land Acquisition & Resettlement	572.0	0.0	572.0	572.0	0.0	572.0
Total	4,767.6	1,133.2	5,900.8	5,038.1	1,205.8	6,243.9

Part 2

Description	Initial (4 lanes)			Final (6 lanes)		
	Cost	Tax & Duty	Total	Cost	Tax & Duty	Total
(1)Construction (including Contingency)	4,198.2	1,161.2	5,359.4	4,481.4	1,239.1	5,720.5
(2)Engineering Service	419.8	87.3	507.1	448.1	93.1	541.3
(3)Land Acquisition & Resettlement	651.4	0.0	651.4	651.4	0.0	651.4
Total	5,269.4	1,248.5	6,517.9	5,580.9	1,332.2	6,913.1

Part 3

Description	Initial (4 lanes)			Final (6 lanes)		
	Cost	Tax & Duty	Total	Cost	Tax & Duty	Total
(1)Construction (including Contingency)	2,674.1	722.2	3,396.3	2,813.3	760.3	3,573.6
(2)Engineering Service	267.4	54.0	321.4	281.3	56.8	338.1
(3)Land Acquisition & Resettlement	275.8	0.0	275.8	275.8	0.0	275.8
Total	3,217.3	776.2	3,993.5	3,370.4	817.1	4,187.5

Part 4

Description	Initial (4 lanes)			Final (4 lanes)		
	Cost	Tax & Duty	Total	Cost	Tax & Duty	Total
(1)Construction (including Contingency)	1,707.1	462.2	2,169.3	1,707.1	462.2	2,169.3
(2)Engineering Service	170.7	34.6	205.3	170.7	34.6	205.3
(3)Land Acquisition & Resettlement	234.4	0.0	234.4	234.4	0.0	234.4
Total	2,112.2	496.8	2,609.0	2,112.2	496.8	2,609.0

Total Cost

	Part	Initial			Final		
		Cost	Tax & Duty	Total	Cost	Tax & Duty	Total
Southern Highway	1	4,767.6	1,133.3	5,900.8	5,038.1	1,205.8	6,243.9
Project Cost	2	5,269.4	1,248.5	6,517.9	5,580.9	1,332.2	6,913.1
	3	3,217.3	776.2	3,993.5	3,370.4	817.1	4,187.5
	4	2,112.2	496.8	2,609.0	2,112.2	496.8	2,609.0
	Total	10,598.9	2,521.5	13,120.4	11,063.5	2,646.1	13,709.6

Tab.12.29 Summary of Project Cost of Foreign and Local Currency in 1999 Prices (million Rs.)

	Part	Stage	Foreign	Local	Total
Southern Highway	1	Initial Stage	2,969.4	2,931.5	5,900.8
		Final Stage	3,156.6	3,087.3	6,243.9
Project Cost	2	Initial Stage	3,277.6	3,240.4	6,518.0
		Final Stage	3,495.0	3,418.3	6,913.3
	3	Initial Stage	1,932.3	2,061.2	3,993.5
		Final Stage	2,037.6	2,150.0	4,187.6
	4	Initial Stage	1,244.3	1,364.7	2,609.0
		Final Stage	1,244.3	1,364.7	2,609.0
	Total	Initial Stage	6,454.2	6,666.3	13,120.5
		Final Stage	6,776.9	6,933.0	13,709.9

12.6.2 Operation and Maintenance Cost

Tab.12.30 shows unit costs for maintenance at the initial and final stages. Tab.12.31 is a summary of the operation and maintenance costs for each part. Additional investment costs consist of the operational costs of utilities such as electricity, water and the cost of pavement overlay, which is to take place every 10 years after the completion of construction.

Tab.12.30 Unit Cost for Maintenance (Rs./km)

Item		Stage	
		4 Lanes	6 Lanes
Routing		33,816	50,724
Sand Sealing		546,167	819,251
Periodic	DBST/SBST	958,773	1,438,160
	Ac Overlay	8,272,767	12,409,151

(*)DBST: Double Bituminous Surface Treatment
SBST: Single Bituminous Surface Treatment

Tab.12.31 Summary of Operation and Maintenance Cost (2005～2039) (million Rs.)

	Southern Highway	Outer Circular Highway			
	Part1	Part2	Part3	Part4	Total
Length (km)	16.32	19.99	8.13	6.82	34.94
Cost	1,190.0	1,440.0	570.0	378.0	2,388.0

CHAPTER 13

ECONOMIC AND FINANCIAL EVALUATION

CHAPTER 13 ECONOMIC AND FINACIAL EVALUATION

In this Chapter, the following results are described:

① Economic evaluation of the OCH project: Subchapter 13-1

② Financial evaluation of the OCH project: Subchapter 13-2

In the economic evaluation, the OCH project is evaluated from the viewpoint of investment efficiency, while in the financial evaluation the following themes are discussed:

* Estimation and evaluation of pseudo user charges for the planned OCH, and
* Evaluation of the financial aspects relevant to the realization of the OCH project.

13.1 Economic Evaluation of OCH Project

13.1.1 Outline of Economic Evaluation on Projects

It is difficult for people to understand the contents and results of an economic evaluation, since the concepts and technical terminology used in the evaluation are different from those used in daily life.

Therefore, in this subsection, in order to understand the contents and results of the economic evaluation of the OCH project, which will be described in given 13.1.2, a general explanation on the economic evaluation of projects is given.

1) Objectives and Stance of Economic Evaluation

a. Economic evaluation of projects are usually carried out from the economic and social standpoints of a country or region where the projects are planned. Standpoints result in technical terminology different from terminology used in daily life.
b. In the case that the main beneficiaries of a project are not residents in the country or the region where the project is planned, the economic evaluation is conducted from economic and social standpoints of the beneficiaries. This is an exceptional case, with the Panama Canal being the best example of this.
c. Theories of economic evaluation have been developed regardirs:

* The economic evaluation of projects from the viewpoint of investment efficiency, and
* Social evaluation.

The main subject of a social evaluation is the distribution of project benefits by income distribution for residents affected by a project. Unfortunately, social evaluation has the following problems:

- Difficulty in collecting basic data for the evaluation, and
- Difficulty in setting evaluation criterion for the results of the analyses.

Accordingly, social evaluation has scarcely been adopted in the world.

d. Based on the above, it can be said that an economic evaluation is usually applied can for evaluating the investment efficiency of projects from economic and social standpoints for a country or region where the projects are planned. Economic evaluation clarifies whether or not projects are worthy from these standpoints and recommends the appropriate measures.

e. On the other hard, a financial evaluation is carried out from the standpoint of a business entity that must consider the costs of project implementation and operation. The main goals of financial evaluation are :

* Evaluation of investment efficiency from a financial standpoint,
* Forecasting the financial situation of a business entity, and
* Drawing conclusions to establish:
  - Desirable levels of user charges,
  - Methods for raising funds to implement and operate projects, and
  - Desirable modes of business

  As a result, in a financial evaluation, the above items a, b and c are irrelevant.

2) Economic Evaluation Method

(1) Outline of the Economic Evaluation Method

A. Procedures of economic evaluation

The procedures adopted for the economic evaluation of the OCH project are shown in Fig.13.1. Comments relevant to this process are follows:

a. The procedures shown which are effective for evaluating investment efficiency .Procedures for social evaluation are not considered.

b. Economic evaluation is carried out with the cooperation of the staff in charge of project cost estimation, since project cost is an essential input in economic evaluation.

c. There are few feedback loops:

Feedback 1 : Feedback of evaluation data to forecasts for economic prices of costs and benefits the numeraire.

Feedback 2 : Feedback of evaluation data for the finalizing of cost and benefit items and the setting of prices and the numeraire.

d. Feedback does not always lead to a satisfactory result. In such a case, the steps of analyzing intangible project costs and benefits of and carrying out a synthetic evaluation after the initial evaluation are also implemented.

e. Since intangible social costs and benefits are bound to exists synthetic evaluation is important.
However, synthetic evaluation requires vision or perspective on the part of the analyst examining the society or economy of a country or region concerned.

B. Analytical Methods for Economic Evaluation

For evaluating the investment efficiency of a project or carrying out a synthetic evaluation, cost benefit analysis is used. However, in the former, only quantifiable data is used, while in the latter intangible aspects are also considered.

C. Necessity of Synthetic Evaluation

Investment efficiency cannot be appropriately estimated based only on the tangible costs and benefits of a project. Intangible social costs and benefits generated by the project must also be reflected in the evaluation of investment efficiency. Detailed discussions on this issue will be developed later.

2) Methods of Finalizing and Estimating Costs and Benefits (1st stage of preparation 1 for economic evaluation)

A. Definitions of costs and benefits.

The costs and benefits generated by projects are generally defined as follows:

Costs:

* Inputs for implementation of projects

* The values of costs are estimated as consumption values or volumes of social, economic, and natural resources supplied domestically and/or from abroad.

Benefits:

* Output of projects
* Values of benefits are estimated as increased values or volumes of social and economic welfare for a country or region.

  Benefits can include those indirectly generated by the project.

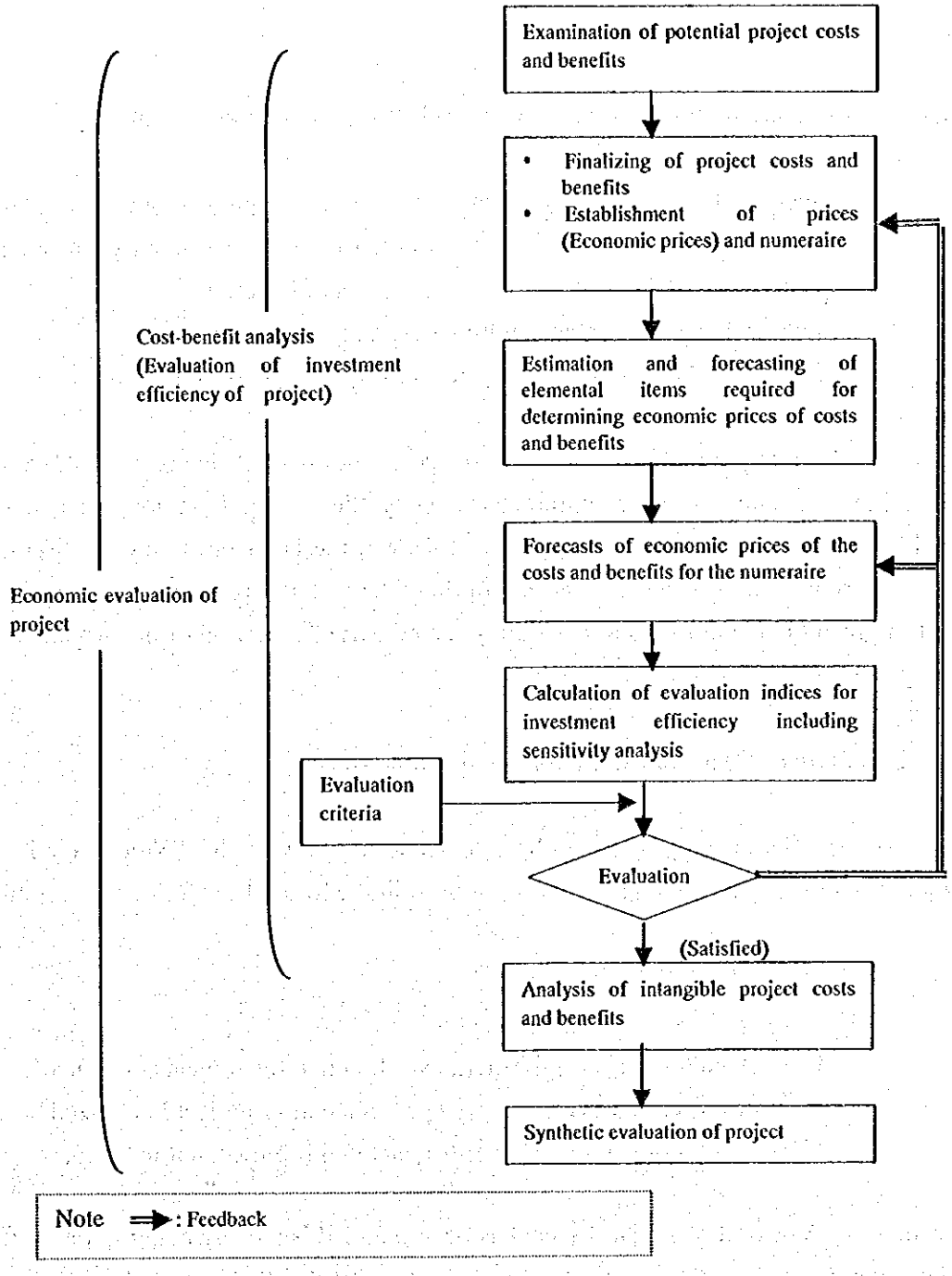

Fig. 13.1 Procedures for the Economic Evaluation of a Project (Evaluation of Investment Efficiency)

B. Principles for selecting Cost and Benefit Items

A) Principles

There are three principles to consider when selecting tangible and intangible cost and benefit items for a project:

Principle 1: Selected costs and benefits of a project shall be plainly observable (in terms of either quantity and quality) in order to avoid attributing incorrect costs or benefits.

Principle 2 : Avoid double counting cost and benefit items.

Principle 3 : Adopt continuously generating cost and benefit items.

There are basically two (2) categories of cost and benefit items : continuously generating and temporarily generating ones. Only the former have to be taken into consideration in an economic evaluation. However, the latter ones may be discussed for the purposes of reference. The multiplier effect of the project which manifests itself in greater demand for materials during the construction period of the project, is an example of this.

C. Calculate of Costs and Benefits Attributable to Project

The costs benefits of the project can be calculated on applying the "With and Without Project Principle". The principle can be expressed in the form of the following formula:

$$V^{p} = V^{pw} - V^{pwo}$$

V^{p} : Values of costs and benefits attributed to the project concerned.

V^{pw} : Values of costs and benefits generated after project in realized.

V^{pwo} : Values of costs and benefits generated if project not realized.

In estimating Vpwo, if a similar project has been planned is already being implemented independently of the project concerned and the facilities of that project for use in the concerned project, the costs of that project are still not attributable to the concerned project. This cost is referred to as a "Suck Cost".

D. Cost and Benefit Items for Calculating Evaluation Indices

From viewpoint of measuring the values of the costs and benefits on a project, they

can be largely classified into two (2) categories:

Category 1: Costs and benefits whose values can be measured or expressed in monetary terms.

Category 2: Costs and benefits whose values are difficult to or can not be expressed in monetary terms.

The former is referred to "tangible costs and benefits" and the latter as "intangible costs and benefits". In calculating evaluation indices, only tangible costs and benefits are taken into consideration. For this reason, it is necessary to consider synthetic economic evaluation for the project as well.

E. Cost and Benefit Items of OCH Project

Based on an analysis structure of the OCH project and taking into consideration the above-mentioned three principles, the following cost and benefit items can be selected for the OCH project.

Tab. 13.1 Cost and Benefit Items of the OCH Project which are taken into Consideration in the Economic Analysis

Purpose of Application	Output of Application	Cost and Benefit Items
Calculation of the Evaluation indices	Tangible cost	① Project cost ② Operation and maintenance costs
	Tangible benefit	① Vehicle running reduction benefit. ② Running time reduction benefit ③ Air pollution reduction benefit ④ Traffic accident reduction benefit
Synthetic economic evaluation	External economy (Intangible benefit)	Contribution of the OCH on socio-economic development in the Western and Southern provinces
	External diseconomy (Intangible cost)	Impacts of the OCH project on physical, Biological and socio environment at the Adjacent stops along the OCH route.

(1) Expressing Prices of Values of Costs and Benefits (2nd of preparation for economic evaluation)

A. Prices Applied for Economic Evaluation

A) Necessity of Expressing Prices Correctly

a. In daily financial transactions, values of goods and services to be transacted are expressed at current prices. Accordingly, they include:

* Price escalation portion, and
* Transfer costs such as taxes.

Project costs, etc., are initially estimated at constant prices. They do not include the price escalation portion but include transfer costs.

b. In the economic evaluation of a project, values must basically be expressed in opportunity cost prices. This is because the evaluation has to be carried out from the socio-economic viewpoints of the country or region concerned.

c. Therefore, values expressed at prices used for daily transactions are unsuitable for the economic evaluation.

B) Prices for Economic Evaluation

Attributes of the prices for economic evaluation are summarized in Tab. 13.2. The prices are constant prices and not current or nominal price. Comments related to these prices are listed below.

a. Behind the adoption of resource value prices and CIF-FOB prices as proxies for opportunity cost prices, there is the following assumption: Almost perfect competition is assumed in the domestic and international markets for the goods and services planned for the project.

b. If the above assumption is invalid, the value of goods and services are to be measured at their opportunity cost prices. To estimate opportunity cost prices, a detailed analysis of the price mechanism of the project goods and services and basic data for estimation are required.

c. There are two types of competition for two types of transaction markets : Competition in the domestic market and international market. For resource value prices and opportunity cost prices, the competition in the international market for the goods and services concerned is not reflected, while it is reflected in the CIF-FOB prices when border prices are adopted as the numeraire for economic evaluation. This issue will be discussed again later.

d. For the values of goods and services measured with any one of the three

categories of prices shown in Tab. 13.2 do not consider the external economies and diseconomies of goods and services. There exists, so to speak, a "Market Failure", since external economies and diseconomies are generated outside of the markets.

Tab. 13.2 Attributes of Prices adopted for Economic Evaluation of Projects

Item	Resource Value Prices	Opportunity Cost Prices	CIF-FOB Prices
Definition	Prices that can be calculated based on the values of goods and services expressed at the resource base. They exclude transfer costs, which are included in at daily transaction prices.	Prices equivalent to maximum values of the goods and services that would be obtained for usage other than that for a particular project. Transfer costs are not included.	Cost – Insurance and Freight (CIF) and Free on Board (FOB) prices of tradable goods and services. Transfer costs are not included
Estimation Method	$P^R=P^T-T+S$ P^R: Resource value of prices for goods and services P^T: Prices at market transaction T : Taxes imposed on goods and services S : Subsidy for goods and services	The value of the goods and services that would be lost by being used in a particular project, which is the maximum value to be obtained if they were used in another project.	Citation of prices from trade statistics
Conditions for Estimation	Transaction market for the concerned goods and service, exists and the market is perfectly competitive.	Either no transaction market exists or it is imperfect.	No conditions required, since semi perfect competition has been a part of competition has been a part of international trade.
Goods and Services Covered	① Goods and services that can be Produced domestically. ② Skilled labor	① Land ② Unskilled labor	① Tradable goods and Services

B. Numeraire adopted for Economic Evaluation

A) Necessity of Adopting a Numeraire

a. As mentioned above, the basic data for economic evaluation consists of domestic economic prices (i.e. , resource value prices and opportunity cost prices) and national border prices (i.e. , CIF – FOB prices).

b. The values of the prices for these two different categories can not be aggregated as they are. Therefore, the values have to be converted into a common yardstick, which is known as a "numeraire". Either value can be converted into the other value to achieve this.

B) Kinds of Numeraires

a. Units of local and international currencies, e.g. the Rupee, US Dollar, EU, and Yen are also types of numeraires used in daily financial transactions. In an economic evaluation, one of the following two types of numeraires is usually adopted:

Type 1 :

* The Type 1 numeraire has been devised from viewpoint that the final objective of implementing a project is to maximize consumption as measured in terms of local currency.
* Therefore, domestic economic prices are used as the numeraire.
* The economic evaluation method that applies this numeraire is called the "UNIDO" method.

Type 2 :

* The type 2 numeraire has been devised from viewpoint that the final objective of implementing a project is to maximize savings as is measured in terms of national border prices.
* Therefore, national border prices are used as the numeraire.
* The economic evaluation method that uses this numeraire is called the "World Bank" or "OECD" method.

b. If Type 1, is the adapted international competitive power of goods and services relating to a project is not taken into consideration, while if type 2 is adapted this power is indirectly considered.

c. Though there is a difference between the two types of numeraires, it is theoretically possible to convert either one into the other.

C) Conversion of Values for Numeraire

a. The main aspects of converting values for a particular numeraire, are shown in Tab. 13.3.

Tab. 13.3 Conversion of Values by Type of Numeraire

	Numeraire 1 (UNIDO Method)	Numeraire 2 (World Bank / OECD Method)
Tradable Goods and Services	Conversion of the values expressed at CIF-FUB prices into the ones at domestic economic prices	
Domestically Produced Goods and Services		Conversion of the values expressed at domestic economic prices into the ones at national border prices

b. For the above-mentioned conversion, the Standard Conversion Factor (SCF) is used.

C. Expressing the Prices of Values Adopted for the OCH Project.

a. For the OCH project numeraire 1, i.e. Sri Lankan domestic economic prices, is adopted as the numeraire for the economic evaluatio, taking into account the following characteristics:

- Benefits of the project, would be enjoyed by only Sri Lankan residents and cannot be exported to foreign countries.
- Resource value prices and opportunity cost prices shown in Tab. 13.2 are used as domestic economic prices.

(2) Evaluation Indices and Evaluation Criteria (3rd stage of preparation or economic evaluation)

A. Formulas for Calculating Investment Efficiency, Evaluation Criterion, and Method of Judgement.

A) Formulas

a. Formulas for calculating investment efficiency are as follows:

$$\sum_{t=1}^{T} \frac{C_t}{(1+r)^{-1}} = \sum_{t=1}^{T} \frac{B_t}{(1+r)^{-1}}$$

* Economic internal rate of return (EIRR, % / annum)

C_t : Cost of the project in year t

B_t : Benefit of the project in year t

r : EIRR

T : Last year of the economic evalualtion period.

* Cost-Benefit Ratio (B/C, scalar)

$$B/C = \sum_{t=1}^{T} \frac{B_t}{(1+\bar{r})^{-1}} \Big/ \sum_{t=1}^{T} \frac{C_t}{(1+\bar{r})^{-1}}$$

$\bar{r}$: Given discount rate (% / annum)

* Net Benefit (B – C, at present value base)

$$B - C = \sum_{t=1}^{T} \frac{B_t}{(1+\bar{r})^{-1}} - \sum_{t=1}^{T} \frac{C_t}{(1+\bar{r})^{-1}}$$

b. Evaluation indices can be summarized into the following two (2) categories:

Category 1 : EIRR and B/C

Category 2 : B-C

The difference between the EIRR and B/C is that the discount rate is regarded either as an endogenous or exogenous variable. In case of the EIRR, evaluation criteria for the EIRR. Accordingly, the EIRR and B/C can be classified into the same category.

c. Values of project costs and benefits must be converted into their present value for the evaluation base year as shown in the three equations. Without this conversion, the costs and benefits of services over time cannot be compared.

B) Evaluation Method for Indices.

Tab. 13.4 Evaluation Method of Calculated Values of Evaluation Indices For Investment Efficiency of the Project

	EIRR	B/C	B - C
Meaning of Indices	Discount rate that makes the present values of costs and benefits equal	Ratio of present value of the benefit to the one of the cost at a given discount rate.	Net value between the present values of the cost and benefit.
Evaluation Criteria for Values of Indices	Social discount rate or opportunity cost of capital	1.0	Expected B - C
Conclusion of Evaluation	If the EIRR exceeds the value of the evaluation criteria, the project is judged feasible, otherwise it is unfeasible.	In the case that the value of the B/C exceeds 1.0, the project is judged feasible; otherwise, it is unfeasible.	In the case that the value of B-C exceeds expected B–C, the project is judged feasible; otherwise, it is unfeasible.

B. Sensitivity Analysis on Feasibility of Project

A) Objectives of Sensitivity Analysis

* To examine the degree of stability of the feasibility of the project, and
* To draw conclusions regarding:
  - cost and / or benefit items that should be carefully examined.
  - the most suitable construction schedule of the project.

B) Sensitivity Analysis Method

a. For the sensitivity analysis, many sets of evaluation indices are calculated, using combinations of sets of values of the costs and benefits of the project. To establish the sets of the values, there are generally two (2) ways :

Way 1: Assume an unique probability distribution for the generation of values, and

Way 2: Assume different types of probability distributions for the generation of values.

b. In general, Way 1 has been applied throughout the world, while Way 2 is rarely used. As for Way 2, there are the following problems:
   * Difficulty in estimating the probability distribution. Also, various kinds of data are required, and
   * Difficulty in evaluating the calculated probability distribution of the endogenous variable (e.g. EIRR). Also, various kinds of the basic data are also required.

C. Evaluation Indices and Sensitivity Analysis for OCH Economic Evaluation

A) Evaluation Indices

a.The three types of indices mentioned above are calculated, i.e. EIRR, B/C and B-C.

b.The social discount rate of 12% per annum in Sri Lanka is adopted for the evaluation criteria of the EIRR.

c.The value of B–C is not evaluated, since the expected B–C not been provided by the client for the OCH project.

B) Sensitivity Analysis

a. Total values for the costs and benefits of the OCH project are adopted for analysis.

b. The above-mentioned Way 1 is adopted for establishing the sets of values.

c. For analysis, the following combinations of sets are adopted, resulting in nine cases of values of indices in total.

Sets of the total values of the cost :

Set 1 : Costs increased by 10% as compared to the initial estimated costs.

Set 2 : Costs unchanged as compared to the initial estimated costs.

Set 3 : Costs decreased by 10% as compared to the initial estimated benefits.

Sets of total values of the benefit :

Set 1 : Benefits increased by 10% as compared to the initial estimated benefits.

Set 2 : Benefits unchanged as compared to the initial estimated benefits.

Set 3 : Benefits decreased by 10% as compared to the initially estimated benefits.

(3) Items Requiring Attention

a. To ensure an accurate judgement of the feasibility of the project, the following should be kept in mind:

* Project Costs should be within a reasonable range,
* Project Benefits should be conservatively estimated,

b. A final decision on the approval of the project should not be based on an unquestioning attitude of the estimated value of the EIRR, since it can contain costs or benefits that may be irrelevant.

13.1.2 Economic Evaluation of OCH Project

1) OCH Project Cost and Maintenance Cost.

In this section, OCH project and operation/maintenance costs are converted into Sri Lankan domestic market prices. The latter is the numeraire for the economic analysis of this project, which has been discussed before.

(1) OCH Project Cost

A. The OCH Project Cost at Domestic Market Prices

Project cost, which is in terms of domestic market prices, is provided by the JICA Study Team. The following should be noted regarding cost concepts:

a. Project cost covers the expenditures required for the construction, engineering services, and land acquisition/resettlement during the period of time required to build the OCH

b. Project cost is are expressed follows:

- Project cost is expressed in Sri Lankan domestic market prices,
- Costs include site costs, and
- Costs are expressed in 1999 constant prices.

c. Some costs are categorized applying the following:

- Foreign cost or domestic cost portion, and
- Taxes and transfer cost items.

The foreign cost portion corresponds to value of materials and services will be imported for the construction of the OCH facilities.

In Tab. 13.5 , OCH project costs at Sri Lankan domestic market prices are tabulated.

Tab. 13.5 OCII Project Cost (excludes Operation&Maintenance Cost and Taxes)

(unit: Millions Rs at 1999 domestic constant prices)

Year	Foreign Portion	Local Portion	Total
2001	0	552	552
2002	881	798	1678
2003	660	1,274	1935
2004	1,632	1,474	3106
2005	972	1,150	2122
2006	772	739	1512
2007	860	1,136	1996
2008	655	684	1339
2009	553	573	1127
2010			
2011			
2012			
2013			
2014			
2015			
2016			
2017			
2018			
2019			
Total	6,986 45.5%	8,380 54.5%	15,367 100%

Source : JICA Study Team

Note: The above calculation excludes operation/maintenance costs and taxes.

B. OCH Project Cost at Economic Prices Base.

A) Outline of Conversion Processes of Domestic Market Prices into Economic Prices

Conversion is via the following process:

Step 1 : Exclusion of taxes and transfer costs from domestic market prices.

Step 2 : Conversion of the foreign portion of domestic market prices, after the exclusion of taxes and transfers cost contained in this portion, into domestic economic prices, and

Step 3 : Estimation of the following at economic prices:

* Land acquisition cost and resettlement cost, and
* Unskilled labor cost.

Detailed discussions on the each step will be developed hereinafter.

B) Project Cost after Exclusion of Taxes and Transfer Cost (Step1)

a. Taxes and transfer costs are not considered as an economic price. This is because that they do not represent the real values of goods and services to be consumed by the project. That is, they are just values transferred among the organizations involved the project.

b. Import duties and the general sales tax (GST) of 12.5% imposed on the market values of goods and services are considered as taxes and transfer costs.

C) Conversion of Foreign Portion (Step 2)

a. The value of the foreign portion after the exclusion of taxes and transfer costs is the CIF (Cast, Insurance and Freight) price. It is, therefore, the price before the imposition of import duties.

b. As mentioned before, the numeraire adopted for the economic evaluation of the OCH project is the Sri Lankan domestic economic price base. In order to express all project costs with a numeraire, the foreign portion has to be converted into a unit for the numeraire. This is because an official exchange rate, such as the Sri Lanka rupee against an international currency such as the US dollar, is unsuitable for measuring the real value of goods and services related to the project. This conversion is done using the following formula:

$$V^D = V^F / SCF$$

V^D : Value of the foreign portion at domestic economic prices.

V^F : Value of the foreign portion measured with the official exchange rate of the Sri Lanka Rupees aginst the US Dollar.

SCF : Standard Conversion Factor (= 0.960)

c. The SCF can be defined as the ratio of the difference between the value of goods and services measured at an official exchange rate and their real value as measured against a numeraire. This is estimated to be 0.960 in Sri Lanka as of the year 1998. The SCF can be estimated by applying the following formula and basic data:

$$SCF = (E^c + I^c)/(E^c + I^c + D^I)$$

E^c : Comodity exports measured at FOB prices.

I^c : Comodity imports measured at CIF prices.

D^I : Inport duty

Tab. 13.6 Basic Data for Estimation of the SCF in Sri Lanka

(unit: Millions Rs at Current Prices)

	① Commodity Exports	② Commodity Imports	③ Import Duty	③/② (%)	①+②+③	(①+②)/(①+②+③) SCF
1990	76,633	107,728	19,342	18.0	203,702	0.905
1991	82,225	126,643	19,754	15.6	228,622	0.914
1992	107,855	153,555	21,640	14.1	283,050	0.924
1993	138,175	193,550	20,819	10.8	352,544	0.941
1994	158,554	235,576	22,596	9.6	416,726	0.946
1995	195,092	272,301	24,373	9.0	491,766	0.950
1996	226,801	301,077	25,464	8.5	553,342	0.954
1997	274,194	346,026	26,626	7.7	646,846	0.959
1998	306,329	380,274	28,924	7.6	715,527	0.960

Source : • Economic and Social Statistics of Sri Lanka, 1998
• Sri Lanka Socioeconomic Data 1999

D) Land Acquisition and Resettlement Costs for the OCH Project at Domestic Economic Prices (Step 3-1)

a. Land acquisition and resettlement costs, which are included in Tab. 13.5, are expressed in economic prices.

b. The basis of the adoption is as follows:

* Basically, costs are to be measured in terms of opportunity cost, i.e., future land use is reflected in the value of land.
* It is assumed that the use of the land for the OCH project would have remained the same as at present.
* As a result, we can regard present costs as an economic price.

E) Labor Cost for the OCH Project at Domestic Economic Prices (Step 3-2)

a. Labor cost can be classified into the following two categories for the economic analysis of the project:

* Skilled labor cost, and
* Unskilled labor cost.

b. It is assumed that there is a skilled labor market in Sri Lanka. The supposition implies that skilled labor cost is already expressed in economic prices, Since the prices of goods and services set in a competitive market represent those at one opportunity cost level.

c. On the other hand, the unskilled labor cost adopted by projects does not always reflect the cost of that labor at economic prices. This is because the market for unskilled labor is imperfect due to regulations, (e.g., minimum labor wage). Accordingly, the cost for unskilled labor must be estimated in opportunity cost terms.

The unskilled labor cost per day in opportunity cost terms is estimated to be 150.95 Rs/day/person for 1997. However, a value of 174.30 Rs for 1997 presented by the RDA has been adopted for calculations.

The opportunity cost is estimated as a arithmetic average of the costs shown in Tab. 13.7.

Tab. 13.7 Basic Data for Estimation of Unskilled Labor Cost in Terms of Opportunity Cost

(unit : Rs/day/person at current prices)

	1995	1996	1997	1998
PLANTATION				
Tea				
Preparation of land (Male)	115.08	134.77	153.33	168.91
Plucking (Female)	84.12	91.52	101.30	114.04
Rubber				
Planting (Male)	127.86	147.23	162.01	174.94
Tapping (Male)	99.28	110.02	118.11	114.52
(Female)	92.18	99.49	106.90	107.05
Coconut				
Digging pets (Male)	158.51	173.40	194.03	220.13
Fuching with sticks (Female)	189.22	208.85	223.06	274.10
DOMESTIC				
Paddy				
Ploughing with mamoties (Mal	133.67	140.77	161.97	185.92
Transplanting (Male)	136.27	148.64	164.63	179.04
(Female)	104.34	110.51	128.76	141.64
Harvesting (Male)	132.89	150.23	163.82	184.46
(Female)	102.89	115.80	133.44	149.56
Average	123.02	135.94	150.95	167.78

Source : All island daily wages in the unorganized sector, Bulletin March 1999, Central Bank of Sri Lanka.

d. The total labor cost in opportunity cost terms that will be adopted in this economic analysis can be estimated by applying the following formula:

$$L_t^{TE} = L_t^{TA} \times \left(\frac{1}{3} + \frac{2}{3} \times \frac{150.95}{174.30} \right)$$

$$= 0.911 \times L^{TA}$$

L_t^{TA} : Total labour cost at the financial cost base.

L_t^{TE} : Total labour cost at the opportunity cost base in year t.

$1/3$: Share of skilled workers as a total number of workers employed for OCH construction.

$2/3$: Share of skilled workers.

(2) OCH Operation and Maintenance Costs

A. OCH Operation Maintenance Costs at Domestic Market Prices.

Tab. 13.8 OCH Operation and Maintenance Costs.

(unit: millions of Rs at domestic market prices)

Year	Operation &Maintenance Costs
2001	0.0
2002	0.0
2003	0.0
2004	0.0
2005	15.5
2006	15.5
2007	30.5
2008	30.5
2009	36.0
2010	40.0
2011	40.0
2012	40.0
2013	40.0
2014	40.0
2015	600.0
2016	40.0
2017	40.0
2018	40.0
2019	40.0
2020	40.0
2021	40.0
2022	40.0
2023	40.0
2024	40.0
2025	600.0
2026	40.0
2027	40.0
2028	40.0
2029	40.0
2030	40.0
Total	2088.0

B. OCH Operation and Maintenance Costs at Domestic Economic Prices

a.OCH operation and maintenance costs in terms of domestic market prices are shown in Tab. 13.8 and are adopted as the economic price for this analysis.

b.The basis for this adoption is as follows:

* Maintenance costs can basically be categorized as an OCH project cost,

and

* Average annual maintenance cost accounts for about 1.3% of total project cost (i.e., construction costs, engineering services costs, and resettlement costs) up till the year 2010, which is a rather small figure.
* As the result of the above, the difference between maintenance cost at market prices and economic prices is relatively small and conversion is therefore not warranted.

2) Benefits Expected from OCH Project

The following four categories of benefits till the year 2020 are presented hereinafter.

a. Vehicle running reduction benefit,
b. Running time reduction benefit,
c. Air pollution reduction benefit, and
d. Traffic accident reduction benefit

These benefits are directly and independently generated by the project and can also be expressed in monetary terms, albeit with some difficulties. Along with the above-mentioned benefits, the project might generate other types of benefits. However, those benefits are not considered to direct and independently generated of the project, and are therefore not taken up.

Yearly values for each benefit till the end of the economic evaluation period of the project are tabulated in Tab. 13.29.

(1) Vehicle Running Reduction Benefit

A. Formula for Benefit Calculation

$$B_t^{VR} = \sum_{t=1} \left[D_{j,t}^{WO} - D_{j,t}^{W} \right] \times VOC_j$$

$D_{j,t}^{wo}$:Total running distance of vehicle type j in the Without project case in year t.

B_t^{VR} :Value of the vehicle running cost reduction benefit in year t at economic prices.

$D_{j,t}^{w}$:Total running distance of vehicle type j in the With project case in year t.

VOC_j :Vehicle running cost of vehicle type j.

t :Year in the economic evaluation period.

B. Input Data for Calculation

A) Annual Running Distance by Vehicle Type for Without/With Project Cases

Tab. 13.9 Total Annual Running Distance by Vehicle Type for Without/With

		1999	2006	2010	2020
Car	Without	1,465	3,068	3,755	5,759
	With		3,016	3,739	5,606
	Net		52	16	153
Motorcycle	Without	373	699	951	1,574
	With		689	941	1,544
	Net		10	10	30
Bus	Without	648	804	876	1,239
	With		799	874	1,225
	Net		5	2	14
Taxi	Without	209	280	344	541
	With		278	340	530
	Net		2	4	11
Lorry	Without	465	832	997	1,475
	With		827	990	1,433
	Net		5	7	42

Source: JICAStudy Team
Note:
(1) A van is considered to be a car.
(2) It is assumed here for the year 2006 that the OCH will extend from Bandaragame to A1.
(3) It is assumed here for the year 2010 that the OCH will be fully completed.

B) Vehicle Operating Cost (VOC) by vehicle type

VOC at economic prices is comprised of two different categories of costs:

Category 1: Opportunity costs for purchasing a vehicle,

Category 2: Costs from owning and using a vehicle.

Both Category 1 and Category 2 can be calculated in proportion to the period of ownership of the vehicle or in proportion to running distance (see Tab. 13.10).

Tab. 13.10 Vehicle Operating Cost (VOC)

(unit: Economic price base in 1999)

	Cost Item	Car (Petrol)	Motorcycle (Petrol)	Bus	Taxi (Petrol)	Van	Lorry
Annual VOC (Proportionate to the period of ownership of a vehicle)	1.Opportunity cost of purchasing vehicle	139,490	7,700	336,700	14,430	197,210	139,490
	2. Personal cost	-	-	120,000	60,000	120,000	130,000
	3. Insurance cost	18,000	3,000	60,000	4,000	25,000	17,000
	4. Depreciation cost	10,810	1,190	134,730	2,250	18,520	21,590
	5. Administration cost	15,950	320	42,000	300	28,700	17,400
	6. Subtotal (Rs/annum)	184,250	12,210	693,430	80,980	389,430	325,480
	For reference (Rs/hour)	460	50	230	70	650	330
Annual VOC (Proportional to running distance (Rs/1,000 km)	7. Fuel cost	1,210	240	1,330	380	1070	1,700
	8. Oil cost	20	10	40	10	20	40
	9. Tyre cost	200	50	660	150	250	610
	10. Maintenance cost	1,200	160	780	90	670	780
	11. Depreciation cost	1,000	220	2,780	120	1,150	1,340
	12. Subtotal Rs /100 km)	3,630	680	5,590	750	3,160	4,470
	Rs /km)	3.6	0.7	5.6	0.8	3.2	4.5
13. Total VOC per km (Rs /km)		12.8	1.9	13.3	3.1	16.2	15.3

Source: JICA Study Team

Item 1 at economic price base

$$\begin{bmatrix}\text{Item 1 at economic}\\ \text{price}\end{bmatrix} = \begin{bmatrix}\text{Item 1 at}\\ \text{Domestic market}\\ \text{price}\end{bmatrix} \times 0.65 \times i^{s}$$

0.65 : % of vehicles at mid life of vehicle type concerned.
(0.65=1/2(1.0 -- Residual value ratio) + Residual value ratio)

i^{s} : Short-term interest rate: 14.8% / annum in 1998

j : Vehicle type

Item 4 and Item 11 at economic price base

$$\begin{bmatrix}\text{Item 4 at economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{purchasing value of}\\ \text{vehicle at economic}\\ \text{price base}\end{bmatrix}_j \times 35\% \times \left[1 - \begin{bmatrix}\text{residual value}\\ \text{ratio}\end{bmatrix}_j\right] / \begin{bmatrix}\text{Life time of}\\ \text{vehicle}\end{bmatrix}_j$$

35% : Allocation ratio for Item 4

$$\begin{bmatrix}\text{Life time of}\\ \text{vehicle}\end{bmatrix}_j = \begin{bmatrix}\text{Life time}\\ \text{running distance}\end{bmatrix}_j / \begin{bmatrix}\text{Average annual}\\ \text{running distance}\end{bmatrix}_j$$

$$\begin{bmatrix}\text{Item 11 at economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{purchasing value of}\\ \text{vehicle at economic}\\ \text{price base}\end{bmatrix}_j \times 65\% \times \left[1 - \begin{bmatrix}\text{residual value}\\ \text{ratio}\end{bmatrix}_j\right] / \begin{bmatrix}\text{Life time}\\ \text{running}\\ \text{distance}\end{bmatrix}_j$$

65% : Allocation ratio to the Item 11.

Item 5 at economic price base.

$$\begin{bmatrix}\text{Item 5 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{Purchasing value of}\\ \text{Vehicle at domestic}\\ \text{Market price}\end{bmatrix}_j \times \begin{bmatrix}\text{Ratio of average}\\ \text{annual administration}\\ \text{cost}\end{bmatrix}_j$$

Item 6 (for reference)

$$\left[\text{Item 6}\right]_j = \begin{bmatrix}\text{Item 6}\\ \text{Subtotal annum}\end{bmatrix}_j \Big/ \left[\begin{bmatrix}\text{Average annual}\\ \text{running distance}\end{bmatrix}_j \Big/ \begin{bmatrix}\text{Average unning}\\ \text{speed of vehicle}\end{bmatrix}_j\right]$$

Item 7 at economic price base

$$\begin{bmatrix}\text{Item 7 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{Price of oil}\\ \text{at CIF price}\end{bmatrix}_j \times 1{,}000\text{km} \Big/ \begin{bmatrix}\text{Consumption}\\ \text{of fuel}\end{bmatrix}_j$$

1,000 km : Running distance of vehicle

Item 8 at economic price base

$$\begin{bmatrix}\text{Item 8 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{Price of oil}\\ \text{at CIF price}\end{bmatrix}_j \times 1{,}000\text{km} \Big/ \begin{bmatrix}\text{Life time running}\\ \text{distance of oil}\end{bmatrix}_j$$

Item 9 at economic price base

$$\begin{bmatrix}\text{Item 9 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{Total type cost}\\ \text{per vehicle}\\ \text{at CIF price}\end{bmatrix}_j \times 1{,}000\text{km} \Big/ \begin{bmatrix}\text{Life time running}\\ \text{distance of Tyre}\end{bmatrix}_j$$

Item 10 at economic price base

$$\begin{bmatrix}\text{Item 10 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = \begin{bmatrix}\text{Average annual}\\ \text{maintenance cost}\\ \text{at domestic market}\\ \text{price}\end{bmatrix}_j \times 1{,}000\text{km} / \begin{bmatrix}\text{Average annual}\\ \text{running distance}\end{bmatrix}_j$$

Item 13 at economic price base

$$\begin{bmatrix}\text{Item 13 at}\\ \text{economic}\\ \text{price base}\end{bmatrix}_j = [\text{Item 6}]_j / \begin{bmatrix}\text{Average annual}\\ \text{running distance}\end{bmatrix}_j + [\text{Item 12}]_j$$

Tab. 13.11 BASIC DATA FOR ESTIMATING VEHICLE OPERATING COSTS (VOC) BY VEHICLE TYPE

RDA Survey for the year 1999

	Item		Vehicle Type *1					
			Car (Petrol)	M/cycle (Petrol)	Bus	3-Wheeler (Petrol)	Van	Lorry
1	Purchase of vehicle (value / vehicle)	CIF* price (Rs)	882,640.00	*2 48,700.00	2,444,000.00	*3 104,700.00	1,007,800.00	1,175,000.00
		Domestic market price (Rs)	1,450,000.00	80,000.00	3,500,000.00	150,000.00	2,050,000.00	1,450,000.00
2	Life time running distance (km)		400,000	100,000	400,000	400,000	400,000	400,000
3	Average annual running distance (km/annum)		20,000	10,000	90,000	35,000	30,000	30,000
4	Average running speed of vehicle in Western Province (km/h)		50	40	30	30	50	30
5	Price of tires per vehicle (Total type cost/vehicle)	CIF * price ----*4 (Rs)	6,120.00	980.00	16,530.00	1,190.00	7,350.00	18,370.00
		Domestic market price (Rs)	10,000.00	1,600.00	27,000.00	1,950.00	12,000.00	30,000.00
6	Life time running distance of tyre (km)		30,000	20,000	25,000	8,000	30,000	30,000
7	Price of fuel (value/litre)	CIF* price (Rs)	12.07	12.07	10.65	12.07	10.65	10.65
		Domestic market price (Rs)	50.00	50.00	13.20	50.00	13.20	13.20
8	Consumption of fuel (km/litre)		10	50	8	32	10	6.25
9	Cost of oil (value/vehicle)	CIF * price ----*5 (Rs)	121.00	24.00	217.00	17.00	121.00	217.00
		Domestic market price (Rs)	500.00	100.00	900.00	71.00	500.00	900.00
10	Life time running distance of oil (km)		5,000	2,000	5,000	2,000	5,000	5,000
11	Average annual maintenance cost (value/vehicle) (Rs)		12,000.00(1st3yrs) 24,000.00(Later)	800.00(1st3yrs) 1,600.00 (Later)	35,000.00(1st3yrs) 70,000.00(Later)	1,500.00(1st3yrs) 3,000.00(Later)	10,078.00(1st3yrs) 20,156.00(Later)	11,750.00(1st3yrs) 23,500.00(Later)
12	Average annual insurance cost (value/vehicle) (Rs)		18,000.00	3,000.00	60,000.00	4,000.00	25,000.00	17,000.00
13	Average annual driver's cost (value/vehicle) (Rs)		Nil	Nil	120,000.00	60,000.00	120,000.00	130,000.00
14	Ratio of residual value of vehicle (%)		30	30	30	30	30	30
15	Ratio of average annual administration cost ---*6 (%) (Administration cost/Purchasing price of vehicle)		0.011	0.004	0.012	0.002	0.014	0.012

Remarks : For item 7, 1.0 US$ = Rs. 71.00

Source : Items 1 & 2: Toyota Lanka (Pvt) Limited and RDA (Mechanical Division)
Items 3 & 4: RDA (Mechanical Division)
Items 5 & 6: RDA (Mechanical Division) and private tyre shops
Items 7: Petroleum Corporation
Item 8: Toyota Lanka (Pvt) Limited and RDA (Mechanical Division)
Items 9 & 10: Lanka Lubricants Ltd. And RDA (Mechanical Division)
Items 11,12,13,14 & 15: RDA (Mechanical Division)

Note : * 1 Figures shown in this table by vehicle type are an average.
* 2 Estimate was based on car purchase price
* 3 Estimate was based on bus purchase price
* 4 Estimate was carried out applying the following formula and data:
Total tire cost = Total tire cost at domestic market price (Rs) / ((1.0 + 1M) x (1.0 + GT) x (1.0 + P))
IM : Import duty = 32% of the CIF price (Central Bank of Sri Lanka Annual Report 1998, P151)
GT : General tax ratio = 10% (Consultant's estimate)
* 5 Estimate was based on relation to price of fuel.
* 6 For Cars, M/Cycles, Buses, 3Wheelers and Lorries, Administrative cost = Managerial cost + Revenue license cost
For Vans Administrative cost = Managerial cost + Revenue license cost + Diesel tax cost

C) Vehicle Running Cost Reduction Benefit till the Year 2020

Adopting the above formulas and input data, cumulative benefits are forecasted for as follows:

Tab. 13.13 Vehicle Running Cost Reduction Benefit
(Unit: Millions Rs at 1998 economic prices)

2006 : 751.6
2010 : 328.7
2020 : 2,521.7

(2) Running Time Reduction Benefits

A. Formulas for Calculating Benefits

A) Passenger running time reduction benefits

$$B_t^{VTP} = \sum_{l=1}\left[H_{l,t}^{wo} - H_{l,t}^{w}\right] \times P_l \times R \times T^P$$

0.43 : Ratio of number of passengers with trip purposes to be evaluated to total number of passengers. To estimate a precise ratio, the following formula is adopted:

$H_{l,t}^{wo}$: Total running time of vehicle type l for Without project case in year t.

$H_{l,t}^{w}$: Total running time of vehicle type l for With project case in year t.

P_l : Average number of passengers for vehicle type l.

T^P : Time value of passengers.

l : Vehicle type (Car, Motorcycle, Bus, Taxi, and Van)

$$R = \left[P^B + P^W + 0.5P^H\right] / P$$

R : Ratio of number of passengers with trip purposes to be evaluated to total number of passengers (here 0.43)

P^B : Number of passengers with the trip purpose "Business"

P^W : Number of passengers with the trip purpose "Work"

P^H : Number of passengers with the trip purpose "Home"

0.5 : Evaluation weigh for saved running time of passengers with the trip purpose "Home"

P : Total number of passenger

It is assumed in the above formulas that the saved/reduced running times of passengers with the above-mentioned trip purposes will utilize this time for productive activities.

B) Cargo running time reduction benefit

B_t^{VTC} : Value of cargo running time reduction benefits in year t

$H_{k,t}^{WO}$: Total running time of vehicle type k for Without project case in year t

$H_{k,t}^{W}$: Total running time of vehicle type k for With project case in year t

W_k : Average weight of cargo for vehicle type k

V^C : Value of cargo per ton

C^S : Short-term interest rate (14.8% / annum, 1998)

k : Vehicle type (Lorry)