INTER-ISLAND RICE DISTRIBUTION PLAN IN INDONESIA

by

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CHAPTER 1

INTRODUCTION

Rice was assigned a crucial role in the success of Indonesia's development program. Indonesia has usually been a net importer of rice since 1951. Although Indonesia as a whole is a deficit rice producer, there are local surplus areas. The locations of surpluses and deficits change from year to year, but few locations have been consistently surplus or deficit areas.

The government has three important responsibilities related to the distribution of rice, these are:

1) Supplying rice to government employees and the armed forces at prices that are reasonable and within the income range of these people.
2) Procuring rice from the domestic market at prices that would be sufficient to encourage the farmers to increase their farm production; if domestic procurement is insufficient it should be reinforced by imports from overseas.
3) To be ready to release rice stocks into the open market to stabilize the economy and prevent the rapid rise of rice prices above the established price.

In general, the government is responsible for the distribution of rice and the stability of rice prices throughout the country.

In the distribution of rice, the cost of the shipping of the rice from surplus areas to deficit areas is a sizeable one. Since Indonesia is composed of several main islands and more than 3000 small islands, a complex inter-island rice shipment problem exists. Other factors that influenced the distribution are the seasonality of rice production, consumption and the availability of transportation facilities. Inter-island shipping is thus an essential part of Indonesia's transportation system. Hence, one of the goals of the government is to determine the rice movement pattern that will minimize the cost of transportation of rice from surplus to deficit regions.

In the analysis of transportation problems, linear programming has been a method that has been used successfully. Transportation or distribution problems were an early example of linear network optimization and is now a standard application for industrial firms having several manufacturing plants, warehouses, sales territories and distribution outlets. The model's primary usefulness is for planning. In this instance, strategic decisions involves selecting transportation routes so as to allocate the production of various plants to several warehouses or terminal points.

The initial work on transportation problems, done by Hitchcock and Koopmans in the 1940's, paved the way for future developments. Subsequent to this pioneering work, many scholars have refined and extended the basic transportation model to include not only the determination of optimal shipping patterns, but also the analysis of production scheduling, transhipment and assignment problems.

In the basic transportation model, the objective is to determine optimal routes of shipment that:

a) originate at sources where stockpiles of a commodity are available;

b) are sent directly to their final destinations where various amounts are required;

c) adjust the stockpiles and fulfill the demand;

Hence, the total demand is set equal to the total supply; finally, the cost must

d) satisfy a linear objective function; that is, the cost of each shipment is proportional to the amount shipped, and the total cost is the sum of the individual costs.

Limited facilities represent tangible, real and measurable situations, such as fixed production capacity, restricted equipment, or any other sort of fixed means for production output. For various physical reasons there are limited capacities which create constraints on the shipment flows from origins to destinations. When these linear constraints are present, the transportation model is called the capacitated transportation model.

The purpose of this study is to develop a rice distribution planning model based on given forecast data. It should be noted that the source of all data is the National Logistics Agency (Bulog), Republic of Indonesia. The problem included routing and shipment scheduling activities.

Basically the problem is to determine an optimal rice distribution pattern so as to minimize the operational cost with the following conditions satisfied:

1) All demands are met.

2) Supplies are limited.

3) Shipping capacity is limited.

4) Warehouse capacities are limited.

5) Seasonal domestic supply.

6) Loading and unloading capacity limitations.

Currently, conventional methods for dealing with the decisions related to the distribution plan rely quite heavily on intuitive judgment. Policies and rules of thumb sometimes can be formulated to guide the applications of sound judgment and lessen the chance that poor judgment is exercised. In making the above decisions one should know accurately the current data related to the distribution plan. Generally speaking, the decision maker does not have all of the current information at his finger tips and if he does it is still difficult to give the data its proper weight in the decision making process.

From what usually is done, a far better means to solve this problem is available with linear programming. In the deterministic models, all parameters are assumed to take fixed, known values, where estimates are provided via forecasts. The impact of this assumption can be tested by means of sensitivity analysis. For example, the impact of uncertain rice production can be assessed indirectly by performing sensitivity analysis. Furthermore, sensitivity tests and shadow price information allow the decision maker to evaluate how well the available resources are balanced. The shadow price associated with any capacity constraint provides a local indication of the saving to be obtained from a unit increase in that limited capacity.

The corresponding model deals with a large number of variables and constraints due to the complex interactions among the choices available to the decision maker. Since these choices are hard to evaluate on merely intuitive basis, a decision maker could benefit greatly from the solutions of the model. Historically, linear programming has been the type of model used most widely, and has contributed a great deal to improving the quality of decisions. In the decision making hierarchy, linear programming models become links between strategic and operational decisions. On the other hand the linear programming models generate the broad guidelines for detail implementation.

The following approach is presented to solve the proposed distribution problem. First, the planning horizon is selected. This planning horizon indicates how long we should look to the future to include all the significant factors of the decision under study. In this particular problem because of the variation of the harvesting pattern throughout the country and the locations of surpluses and deficits change from year to year, we select the planning horizon to be from April to March of the subsequent year.

Having the fixed planning horizon, the next step is to develop the mathematical programming models which are used to determine the optimal distribution plan. Because of the nature of the problem, linear programming is used to solve the problem. The model is developed in two stages. The first stage is a basic transportation model. This model is used to obtain an overall distribution pattern without imposing any physical constraints, such as shipping capacity constraints. The input data includes the estimates of a) domestic supply, b) demand requirements, and c) shipping costs. The constraints imposed on this model are demand requirements and the limited domestic supply. The solutions of the model are used for selecting the optimal rice shipping pattern that will minimize the total shipping cost. These solutions are the overall best solution possible which are useful in providing general guidelines for the planning process. It may be noted that import variables are involved in this model since the domestic supply is insufficient. In real life, the corresponding ships available may be finite over some or all of the routes.

In the second stage the model is further developed by adding the existing shipping capacities as upper bound constraints to the first stage model. This then, is a capacitated transportation model which we will use to determine the distribution pattern which will serve as the basis for further iterative modification. This model is as close to the actual problem as we can solve with existing solution techniques. The solution of the capacitated transportation model yields the total amount, in metric tons of rice, to be shipped from supply ports to deficit ports and to be imported from overseas to importing ports for a one year plan.

The next task required is to schedule the rice shipment in order to meet the various demand in each period (month). The constraints which are to be satisfied in this shipping schedule are:

1) Demand fluctuations. This constraint ensures that the demand requirement for each period will be met.

2) Number of ship trips available. This constraint insures that each shipment should not exceed the predetermined capacity per trip in the respective routes and the frequency of shipments should not exceed the

number of the ship trips available during the planning horizon considered.

3) Warehouse capacities. This constraint insures that the amount of any shipment should be adjusted so that the amount of inventory at the end of any period should not exceed the corresponding warehouse capacity.

4) Seasonal domestic supplies. This constraint insures that the total amount of rice shipped from any local surplus port should not exceed the available supply in a corresponding period.

5) Loading and unloading capacities. In real life, these constraints may be a function of the working rules, labor forces, crane capacities, or any set of operations. This constraint insures that any handling activity (onloading or offloading) at any port does not take more than the number of working days in a corresponding period.

The problem then becomes one in which we determine the actual shipping schedule which will accommodate the optimal distribution so as to minimize the number of shipments during a planning horizon in order to minimize the setup costs and grain losses subject the constraints 1,2,3,4 and 5. Since the problem deals with the discrete number of shipments, the shipping schedule can be considered as an integer programming problem. There are no solution techniques available to solve this large integer programming problem. Currently, difficult scheduling problems are solved by relying on intuition, heuristics, or some form of explicit or implicit enumeration. For these reasons the rice shipment scheduling is solved interactively by successively adjusting the constraints with the hope that near optimal schedules are obtained. The interactive process to solve the schedule problem is done by checking each shipment in any corresponding period, which constitutes the optimal distribution pattern, so that the constraints 1,2,3,4 and 5 are satisfied.

The solution may result in one or more of these constraints not being satisfied. These situations are treated by the iterative method as follows.

1 and 4) Demand fluctuation and lack of supply in surplus ports early in the crop season. Recall that the optimal distribution pattern insures that the total demand is met within the shipping capacity available. Because of the seasonality of the domestic surplus, the rice shipments from local surplus ports to the deficit ports, are critical. In this situation, the government acquires most of its domestic procurement during the three month of May, June and July, immediately after the main crop harvest. Therefore the domestic supplies available in the first period may be insufficient to supply the corresponding deficit ports. This difficulty can be handled by adjusting the carry over or initial inventory. This is the reserve margin we wish to maintain so that we can have a uniform supply covering minor unplanned fluctuations. The adjustment of the initial inventory can be done by reallocating all of the carry over inventory available so that the various demands and the optimal shipping routes are satisfied. If not enough surpluses are available, the requirements are supplied by importing or transhipment. This difficulty does not occur for importing ports since the corresponding deficit can be supplied from imports directly whenever needed.

2) Number of ship trips available. It may sometime occur that the availability of ships is insufficient to haul the rice in a particular

period, although the total shipping capacity of the corresponding optimal route is available over the entire planning period. In order to satisfy the optimum shipping pattern, a charter ship is engaged. As a result, the total shipping cost is greatly increased.

3) Warehouse capacity constraints. The lack of warehouse capacity may be such that the incoming rice and the amount in inventory cannot be accommodated. This difficulty can be overcome by renting additional warehouse space. This situation is useful in determining the necessity of constructing new warehouses for future use.

5) Loading and unloading capacity constraints. When the loading and unloading capacity is not enough at any port, overtime is allowed. Normally, the government is willing to pay the overtime costs due to the high ship demurrage cost. The port facilities have been improved to handle the increased volume efficiently.

We iteratively make all the adjustments requires so that all the constraints are satisfied. This then is our final distribution plan.

The LP model is the heart of the planning system. It can be used in determining the impact of unexpected occurrences, such as natural disasters, to the distribution program. The solution of the model yields strategic decisions which include the selection of the optimal shipping routes so as to best allocate the domestic surpluses and imported rice to satisfy the various demands. Also as part of the solution, shadow prices and ranges on shipping costs are computed which are useful in evaluating distribution alternatives.

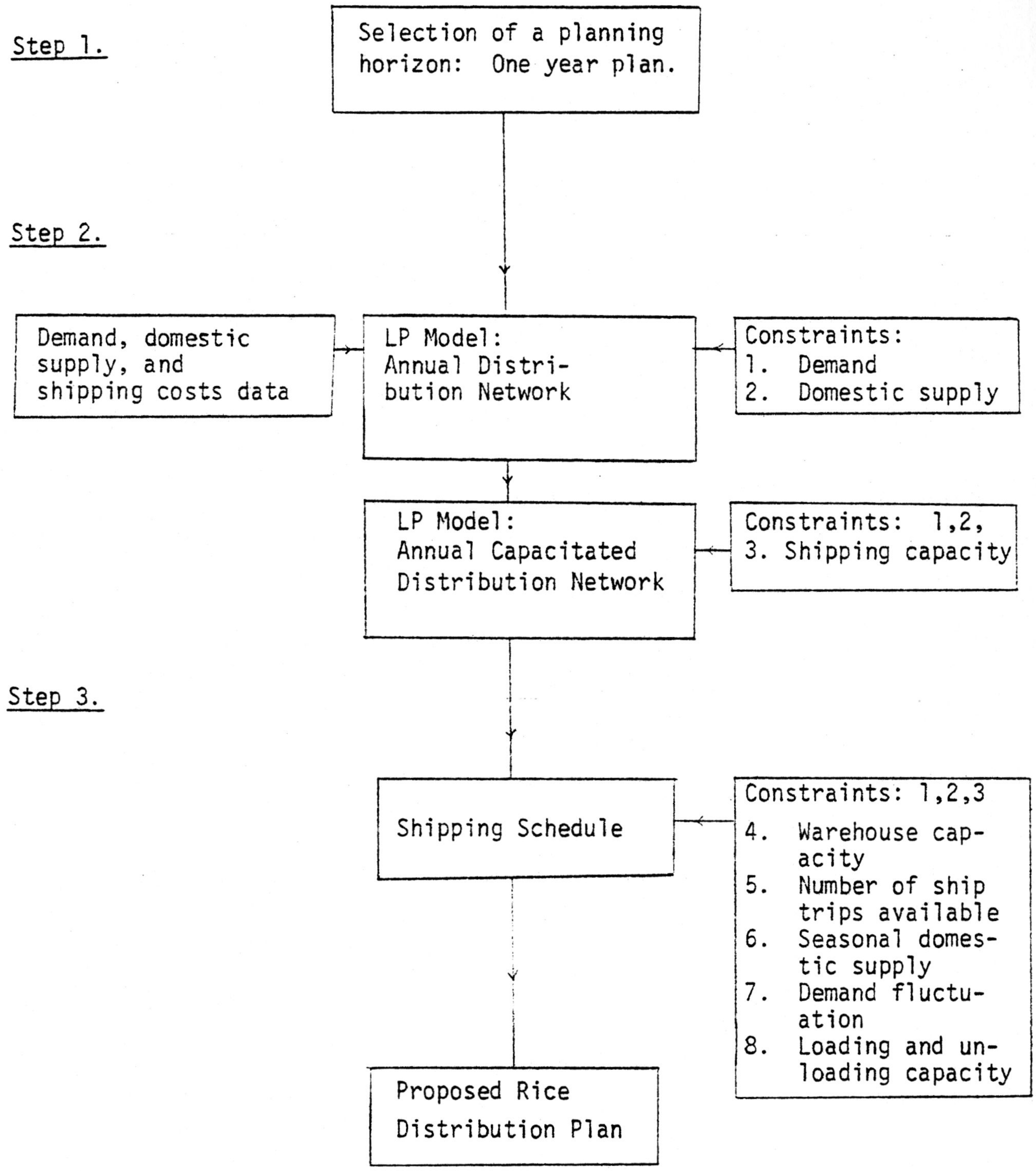


Figure 1.1. Sequence of steps in solving rice distribution plan.

The summary of the method is shown in Figure 1.1. The main purposes of this integrated approach are: i) to reduce the complexity and scope of the problem to a manageable size, ii) to provide a verbal description of the distribution plan and generate reports from the LP model so that managers can read and use them for day-to-day decisions.

In Chapter 2, a basic shipping pattern and a capacitated shipping pattern are presented. These models are solved by using the IBM MPS/360 computer programming package. Shadow prices and ranges on shipping costs are presented in Appendix I and II.

In Chapter 3, the rice shipping schedule is presented. This shipping schedule is solved by an interactive process. The description of constraints imposed are also presented.

In the final chapter, concluding remarks and recommendation for further study are presented.

origin must dispose of exactly the quantity a_i, while the j^{th} destination must receive exactly the quantity b_j. It is assumed that the total demand equals the supply, that is,

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j \tag{1}$$

Besides the numbers, a_i and b_j, which are nonnegative, there are also given a set of numbers, c_{ij}, which may be unrestricted. The number c_{ij} represents the cost (or profit, if negative) of shipping a unit quantity from origin i to destination j. The problem is to determine the number of units, x_{ij}, to be shipped from i to j in order that stockpiles will be depleted and needs satisfied at an over-all minimum cost.

The special structure of the matrix is evident when the equation are written in standard form, as in

$$\begin{array}{llllll}
x_{11} + x_{12} + x_{13} + \ldots + x_{1n} & & & & & = a_1 \\
 & x_{21} + x_{22} + \ldots + x_{2n} & & & & = a_2 \\
 & & x_{m1} + x_{m2} + \ldots + x_{mn} & & & = a_n \\
x_{11} & x_{21} + \ldots + & x_{m1} & & & = b_1 \\
\quad + x_{12} & \quad + x_{22} \ldots + & \ldots \quad x_{m2} & & & = b_2
\end{array}$$

$$c_{11}x_{11} + c_{12}x_{12} + \ldots + c_{1n}x_{1n} + c_{21}x_{21} + \ldots + c_{2n}x_{2n} + c_{m1}x_{m1} + \ldots + c_{mn}x_{mn} = z$$

The first (m+n) equations are the material balance equations at the ports. They state

$\begin{pmatrix}\text{Flow out} \\ \text{of a port}\end{pmatrix} - \begin{pmatrix}\text{Flow into} \\ \text{a port}\end{pmatrix} = \begin{pmatrix}\text{Net supply} \\ \text{at a port}\end{pmatrix}$

It is important to recognize the special structure of these balance equations. Note there is one equation for each point in the network. The flow variables x_{ij} have only 0, + 1, and -1 coefficients in these equations. Further, each variable appears in exactly two equations, once with a +1 coefficient, corresponding to the point from which the transportation link emanates; and once with a -1 coefficient, corresponding to the point with which the link is connected. The remaining row gives the cost of shipping one unit of flow across a link.

Using the following notation, the so called classical "transportation problem", can be stated as follows:

Minimize the objective function

$$\sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \qquad (2)$$

subject to the constraints

$$\sum_{j=1}^{n} x_{ij} = a_i, \qquad i = 1,2, \ldots, m$$

$$\sum_{i=1}^{m} x_{ij} = b_j, \qquad j = 1,2, \ldots, n$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

$$x_{ij} \geq 0$$

These equations are represented in a tableau form as follows:

Table 2.1. A transportation tableau.

Source	Destinations 1	2	...	n	Supply
1	c_{11} x_{11}	c_{12} x_{12}	...	c_{1n} x_{1n}	a_1
2	c_{21} x_{21}	c_{22} x_{22}	...	c_{2n} x_{2n}	a_2
3	c_{31} x_{31}	c_{32} x_{32}	...	c_{3n} x_{3n}	a_3
⋮	⋮	⋮		⋮	⋮
m	c_{m1} x_{m1}	c_{m2} x_{m2}	...	c_{mn} x_{mn}	a_m
Demand	b_1	b_2	...	b_n	Total

Each row in the tableau corresponds to source point and each column to a destination ports. The numbers in the final column are the supplies available at the source ports and those in the bottom row are the demands required at the destination ports . The entries in cell i-j in the tableau denote the flow allocation x_{ij} from source i to destination j and the corresponding cost per unit of flow is c_{ij}. The sum of x_{ij} across row i must equal a_i in any feasible solution, and the sum of x_{ij} down column j must equal b_j.

In the classical transportation problem, the objective is to determine an optimal schedule of shipments that:

(a) originate at a source (supply ports) where fixed stockpiles of a commodity are available;

(b) are sent directly to their final destinations (demand ports) where various amounts are required;

(c) adjust the stockpiles and fulfill the demand; hence, total demand equals total supply;

and finally, the cost must

(d) satisfy a linear objective function; that is, the cost of each shipment is proportional to the amount shipped, and the total cost is the sum of the individual cost.

In the classical transportation problem we allow the possibility of infinite shipping capacities over all of routes. In many applications these shipping capacities may be finite over some or all of the routes. The "capacitated transportation problem" includes these constraints and can be stated as follows:

Find x_{ij} as to minimize

$$z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}x_{ij} \tag{3}$$

subject to the constraints:

$$\sum_{j=1}^{n} x_{ij} = a_i$$

$$\sum_{i=1}^{m} x_{ij} = b_j \qquad \begin{array}{l} i = 1,2, \ldots, m \\ j = 1,2, \ldots, n \end{array}$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

$$x_{ij} \leq e_{ij}$$

$$x_{ij} \geq 0$$

where e_{ij} represents the capacity or upper bound for shipments from origin i to destination j.

3. The Basic Pattern Rice Transportation Model.

The input data necessary for the basic transportation model include estimates of (1) regional surpluses, (2) regional consumption and (3) transportation costs. Several terms used in this section need to be defined. These are:

1) Rice deficit provinces refers to those provinces where the consumption of rice for the entire year exceeds its production.
2) Rice surplus provinces refers to those provinces where the production exceeds consumption for the year.
3) Domestic supply refers to the domestic procurement availability which equal the quantities of rice available for purchase during the planning horizon under consideration.
4) Demand refers to rice deficiencies.
5) Imports refer to rice shipped into any Indonesian port from sources outside Indonesia.

The basic assumptions of the transportation model formulation are:

1) The cost of shipping from supply ports to demand ports are known and constant over all quantities shipped.
2) The sum of the quantities available from all of the supply ports must equal the sum of the quantities required by all of the demand ports.

3) All domestic supply quantities available must be shipped to demand ports and all demands must be satisfied.

4) All rice not consumed in a rice surplus province must be shipped out of that province within the year that it is produced and must be shipped to one or more rice deficit provinces.

5) All rice needed to offset rice deficits must be provided in the year that the rice deficiency exists either by rice from the rice surplus provinces or from imports.

6) No rice may be exported from an Indonesian province during a year in which rice is imported by any Indonesian province.

7) Supply and demand are considered fixed during the planning horizon. There exists the means for producing a reliable forecast of the demand and procurement during the planning horizon being considered. These forecasts should be meaningful to both the purchasing and distribution departments.

8) Some ports, which are designated as destinations for imported rice, are considered as supply ports.

The cities designated as origination or destination ports for rice shipments between provinces are listed in Table 2.2. (see an Indonesian map). The cities selected were major ports located in provinces. The transportation costs between these cities were usually based on the reported available minimum costs of shipping rice.

Java plays a specially important role in inter-island trade. Its population is about 60 percent of the total population. It is the main entry point for foreign goods and the principal point of distribution

Table 2.2. Departure and destination ports.

Province	Destination and/or Departure Cities	Notation
West Java	Jakarta, Cirebon	P_7, P_8
Central Java	Semarang	P_{10}
East Java	Surabaya	P_{11}
Aceh	Banda Aceh	R_1
North Sumatra	Medan (Belawan)	P_1
West Sumatra	Padang	P_2
Riau	Pakanbaru, Dumai,	R_3, P_3
	Bengkalis, Bagansiapi,	R_5, R_2
	Tanjung Pinang	R_4
Jambi	Jambi, Pangkal Pinang,	R_7, P_5
	Tanjung Pandan	P_6
Bengkulu	Bengkulu	R_6
South Sumatra	Palembang	P_4
Lampung	Pajang	R_8
West Kalimantan	Pontianak	P_9
South Kalimantan	Banjarmasin	R_9
East Kalimantan	Samarinda, Balikpapan,	R_{11}
	Tarakan	R_{10}

Table 2.2 (continued)

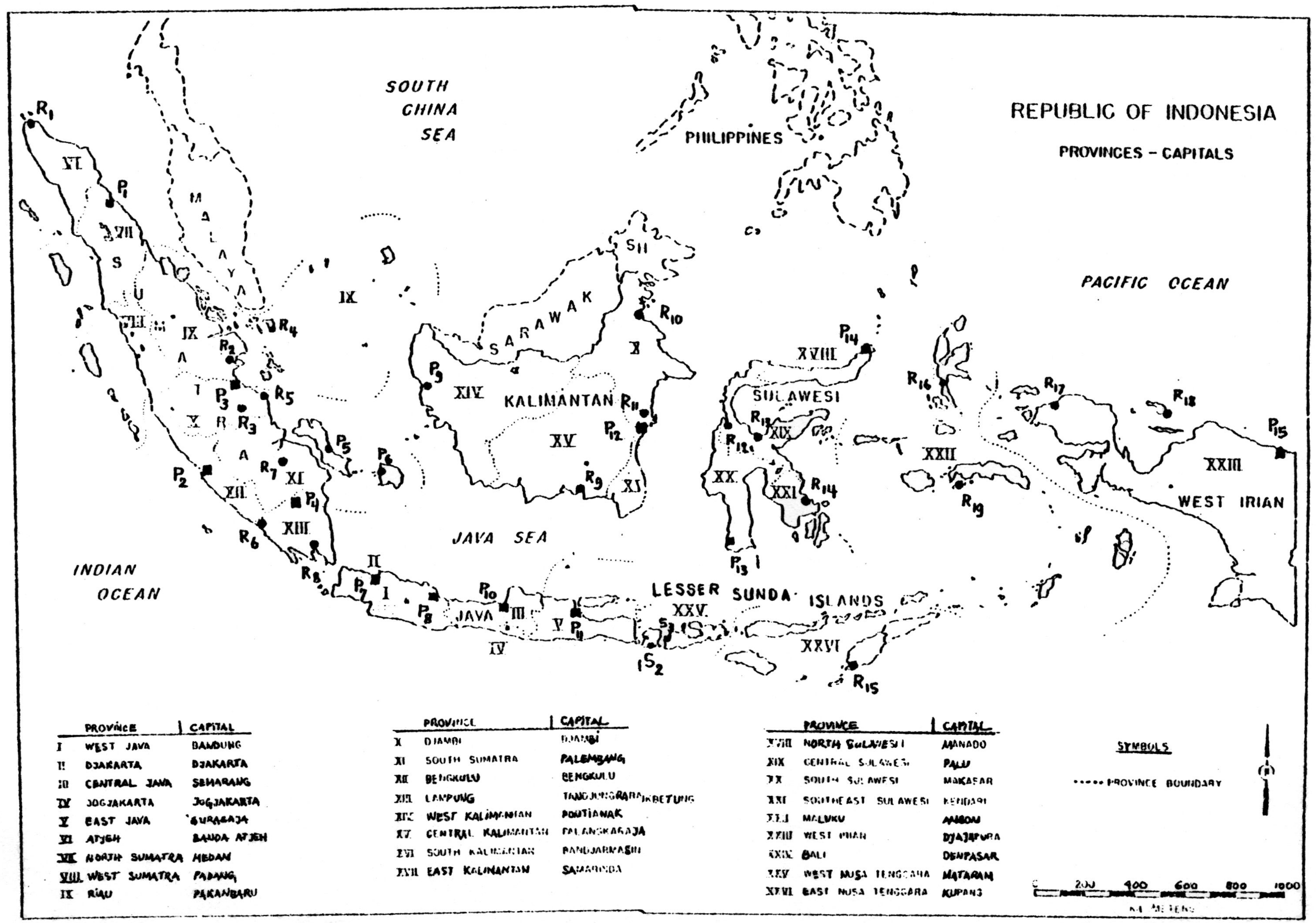
Province	Destination and/or Departure Cities	Notation
North Sulawesi	Bitung	P_{14}
Central Sulawesi	Palu, Poso	R_{12}, R_{13}
South East Sulawesi	Kendari	R_{14}
South Sulawesi	Ujung Pandang (Makasar)	P_{13}
Maluku	Ambon, Ternate	R_{19}, R_{16}
Bali	Benoa	S_2
West Nusa Tenggara	Ampenan	S_3
East Nusa Tenggara	Kupang	R_{15}
West Irian	Jayapura, Biak,	P_{15}, R_{18}
	Sorong	R_{17}

P_j = deficit ports and international importing ports. (j=1,2,...,9,12,...,15)

P_i = local surplus ports and international importing ports. (i=10,11)

S = local surplus ports

R = deficit ports


REPUBLIC OF INDONESIA
PROVINCES - CAPITALS
SOUTH CHINA SEA
PHILIPPINES
PACIFIC OCEAN
INDIAN OCEAN
JAVA SEA
SARAWAK
KALIMANTAN
SULAWESI
JAVA
LESSER SUNDA ISLANDS
WEST IRIAN
MALAYA
SUMATRA
PROVINCE | CAPITAL
I WEST JAVA | BANDUNG
II DJAKARTA | DJAKARTA
III CENTRAL JAVA | SEMARANG
IV JOGJAKARTA | JOGJAKARTA
V EAST JAVA | SURABAJA
VI ATJEH | BANDA ATJEH
VII NORTH SUMATRA | MEDAN
VIII WEST SUMATRA | PADANG
IX RIAU | PAKANBARU
PROVINCE | CAPITAL
X DJAMBI | DJAMBI
XI SOUTH SUMATRA | PALEMBANG
XII BENGKULU | BENGKULU
XIII LAMPUNG | TANDJUNGKARANG-TELUKBETUNG
XIV WEST KALIMANTAN | PONTIANAK
XV CENTRAL KALIMANTAN | PALANGKARAJA
XVI SOUTH KALIMANTAN | BANDJARMASIN
XVII EAST KALIMANTAN | SAMARINDA
PROVINCE | CAPITAL
XVIII NORTH SULAWESI | MANADO
XIX CENTRAL SULAWESI | PALU
XX SOUTH SULAWESI | MAKASAR
XXI SOUTHEAST SULAWESI | KENDARI
XXII MALUKU | AMBON
XXIII WEST IRIAN | DJAJAPURA
XXIV BALI | DENPASAR
XXV WEST NUSA TENGGARA | MATARAM
XXVI EAST NUSA TENGGARA | KUPANG
SYMBOLS
PROVINCE BOUNDARY
0 200 400 600 800 1000
KILOMETERS

of consummer and manufactured goods. The two major international ports in Java are Jakarta in West Java and Surabaya in East Java. Jakarta, the capital city and a center of government administration, has considerable storage capacity, about 250,000 metric tons. East Java has been a consistent surplus area for years. Thus it is possible to ship rice from these two ports to all destination ports. The other origination ports are referred to as the supply ports for the demand ports in their region.

The domestic shipping cost per metric ton of rice (in bags) from each supply port to each demand port is given in the shipping cost structure, Table 2.3. The importing shipping costs per metric ton varies between Rp 2500.00 to Rp 3500.00 where 415 Rupiah (Rp) equals 1 U.S. dollar. In this particular problem the importing shipping costs per metric ton from any foreign departure port to the import destinations are assumed fixed and equal to Rp 3000.00.

As in the classical transportation problem, we want to determine an optimal schedule of shipments that satisfies the demand. Since the domestic surpluses have first priority to be shipped, they can be handled by assigning a penalty cost to the imported rice. The penalty cost is the difference between the price of imported rice and the price of domestic rice per metric ton. An alternative to allocating the domestic surplus is by simply adding an equality constraint to the model which states the total demand is equal to the sum of the domestic surplus and imports. The demand and supply (domestic procurement and imports) forecast data is given in Table 2.4.

Table 2.3. Domestic shipping cost structure (see Table 2.2 for port identification)

To ports (columns) / From ports (rows)

From ports	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}
P_1		3928	2128	3504			3976	4040		4280	4552				
P_2	3928			3928			3376			3882	4152				
P_3	2128			3112			3576	3632		3880	4120				
P_4	3504	3928	3112		1800	2248	2680	2968	2790	3216	3536		4280		
P_5				1800		1088	2336	2680		2928	3264				
P_6				2248	1088		2000	2336		2632	3072				
P_7	3976	3376	3576	2680	2336	2000		1512	3064	2096	2912	3800	3832	5440	6672
P_8	4040		3632	2968	2680	2336	1512		3024	1216	2336	3480	3496	5344	-
P_9				2790			3064	3024		3160	3344	3760	3944		
P_{10}	4280	3882	3880	3216	2928	2632	2096	1216	3160		1808	3400	3416	5024	-
P_{11}	4552	4152	4120	3536	3624	3072	2912	2336	3344	1808		3216	3160	4672	6208
P_{12}							3800	3480	3760	3400	3216		2472	3464	
P_{13}				4280			3832	3496	3944	3416	3160	2472		3808	5248
P_{14}							5440	5344		5024	4672	3464	3808		
P_{15}							6672	-		-	6208		5248		
S_2			4568				3512	3176		3112	2048	5552	2192		
S_3						3400	3344	-		2928	2032	3016	2432	4152	5824

From ports	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}	R_{17}	R_{18}	R_{19}
P_1	2256	2320	2880	2944	2336		4224												
P_2	3528					1992		3216											
P_3	4500	1088	1488	2048	680		4500												
P_4		2480	3272	2224	2944	3368	2288	3040											
P_5		3000	6500	2008	6000	2200	2376	6100											
P_6		3500	6750	2528	6250	2776	2776	6300											
P_7	4344	3608	3696	3112	3416	2824	3232	1304	3264	4552	4080	3984	5360	4456	4320	5136	5528	15000	6672
P_8									2960	5000	3600	6000	7500	6200					
P_9									3400	5000	3928								
P_{10}	4648	3912	4016	3408	3720	3312	3536	2656	2688	4368	3536	3584	7250	6100					
P_{11}	4920	4192	4560	3576	3944	3632	3696	3248	2280	3936	3328	3368	4552	3752	3536	4440	4906	5816	6208
P_{12}									2624	2888	1080	1800	7500	6000	3112		8000		
P_{13}									2840	3408	2632	2600	4500	2736		3640	3984	4632	5248
P_{14}										3784	3544	3064	2624	5000		2248	3112	10000	10500
P_{15}														5500		2576	2680	3680	4179
S_2									4750	5000	5000	4600	7000	5750	4500				
S_3									5000	5000	5250	3120	7100	5500	3016				

*Source: Bulog 1974

U.S. $1.00 = Rp 415.00

(Rp = Rupiah)

Table 2.4. The demand and supply forecast data (metric tons per year)

Ports	(1,000 metric ton of rice) supply (+) or demand (-)	Notation
Banda Aceh	- 10	DR_1
Bagansiapi	- 2	DR_2
Pakanbaru	- 5	DR_3
Tanjung Pinang	- 16	DR_4
Bengkalis	- 5	DR_5
Bengkulu	- 12	DR_6
Jambi	- 28	DR_7
Pajang	- 15	DR_8
Banjarmasin	- 22	DR_9
Tarakan	- 6	DR_{10}
Samarinda	- 15	DR_{11}
Palu	- 10	DR_{12}
Poso	- 10	DR_{13}
Kendari	- 9	DR_{14}
Kupang	- 20	DR_{15}
Ternate	- 10	DR_{16}
Sorong	- 7	DR_{17}
Biak	- 13	DR_{18}
Ambon	- 25	DR_{19}
Medan	-100	DP_1
Padang	- 28	DP_2
Dumai	- 14	DP_3

Table 2.4. continued

Ports	(1,000 metric ton of rice) supply (+) or demand (-)	Notation
Palembang	- 60	DP_4
Pangkal Pinang	- 30	DP_5
Tomjung Pandan	- 15	DP_6
Jakarta	-300	DP_7
Cirebon	- 35	DP_8
Pontianak	- 30	DP_9
Semarang	+ 30	CSP_{10}
Surabaya	+200	CSP_{11}
Benoa	+ 10	CS_2
Ampenan	+ 10	CS_3
Balikpapan	- 15	DP_{12}
Ujungpandang	- 50	DP_{13}
Bitung	- 45	DP_{14}
Jayapura	- 20	DP_{15}

*Source: Bulog 1974

3.1 The Outline of the Model

3.1.1. Determine the exogenous flows.

Determine the net input or output for the system as a whole. The input is the total surplus at each supply port, and the output is the total amount required for the system.

3.1.2. Determine the material balance equations.

Let X_1, X_2, ..., be the amount, in metric tons of rice, to be shipped or received, then write the material balance equation which insures that input is equal to output. The set of material balance equations together with the conditions that all activity levels be nonnegative, constitutes the linear programming model for the transportation problem. The mathematical model of this transportation problem can be stated as follows:

Notation.

a) Ports:

i = local surplus port

$\bar{k}$ = local surplus port and international importing port ($\bar{k} \varepsilon i$)

j = deficit port

k = deficit port and international importing port ($k \varepsilon i$)

b) Variables:

X_{ij} = the amount, in metric tons of rice, to be shipped from i to j

X_{ik} = the amount, in metric tons of rice, to be shipped from i to k

X_{kj} = the amount, in metric tons of rice, to be shipped from k to j

$X_{\bar{k}j}$ = the amount, in metric tons of rice, to be shipped from $\bar{k}$ to j

$I_k, I_{\bar{k}}$ = the amount, in metric tons of rice, to be imported from overseas to destination k and $\bar{k}$.

c) Parameters:

$C_k, C_{\bar{k}}$ = the importing shipping cost per metric ton from any foreign port to destination k or $\bar{k}$

C_{ij} = the domestic shipping cost per metric ton from origin i to j

$S_i, S_{\bar{k}}$ = domestic surpluses available, in metric tons of rice, at i and $\bar{k}$

D_j, D_k = demand requirements, in metric tons of rice, at j and k

Mathematical model.

The objective function to be minimized is the total domestic shipping cost plus the total importing shipping cost. That is,

$$Z = \sum_{i,j} C_{ij}X_{ij} + \sum_{k} C_k I_k + \sum_{\bar{k}} C_{\bar{k}} I_{\bar{k}}$$

subject to constraints:

1) The amount, in metric tons of rice, shipped from local surplus i to all deficit j should not exceed the amount of the surpluses available at i. That is

$$\sum_{k,j} X_{ij} \leq S_i \qquad (k \varepsilon j)$$

2) The amount, in metric tons of rice, shipped from all local surplus ports i to the deficit port j must equal the demand at j. That is

$$\sum_{\bar{k},i} X_{ij} = D_j \qquad (\bar{k} \varepsilon i) \quad (k \varepsilon j)$$

3) The amount, in metric tons of rice, shipped from a local surplus port $\bar{k}$ to all deficit ports j should not exceed the domestic surplus available plus the imported rice at $\bar{k}$. That is

$$\sum_{\bar{k},j} X_{\bar{k}j} \leq S_{\bar{k}} + I_{\bar{k}} \qquad (k \varepsilon j)$$

or

$$\sum_{\bar{k},j} X_{\bar{k}j} - I_{\bar{k}} \leq S_{\bar{k}}$$

4) The amount, in metric tons of rice, shipped from any port i to the deficit port k plus the imported rice at port k must equal the demand at port k plus the amount to be shipped from k to all deficit ports j. That is

$$\sum_{\bar{k},i} X_{ik} + I_k = D_k + \sum_j X_{kj}$$

It should be noted that the shipping of rice between surplus ports i and $\bar{k}$ is not allowed.

5) The total amount, in metric tons of rice, of domestic surplus plus imports must meet the total demand requirements for all ports j and k. That is

$$\sum_k I_k + \sum_{i,\bar{k}} S_i = \sum_k D_k + \sum_j D_j$$

6) Finally, none of the variables may have negative values, these are:

$$X_{ij}, X_{kj}, I_k, I_{\bar{k}} \geq 0 \qquad \text{(for all } i,j,k,\bar{k})$$

3.2. Model Formulation.

3.2.1. Selection of a Time Horizon

The locations of surpluses and deficits change from year to year. The differences of climates, soil conditions and supply of water in various provinces affects the timing of harvests, number of harvests and relative sizes of crops through one year. Accordingly, the planning horizon selected is one year, from April to March of the subsequent year.

3.2.2. Selection of Decision Variables and Parameters

In developing a linear programming model for this transportation problem it was necessary to determine what variables were required. Usually these variables depend on whether they can be controlled and the importance they play in the cost picture. In this model the important variables considered are:

1) the amount, in metric tons of rice, to be shipped directly from supply port i to final destination port j and fulfill the demand at port j.
2) the amount, in metric tons of rice, to be imported directly from overseas to destination k and fulfill the demand at port k.

The parameters of the problem are represented by the demand requirements, available supply and the shipping cost information. The linear programming model of this transportation problem is illustrated in Figure 2.1. The material balance, supply available, demand and shipping cost equations in Figure 2.1 are discussed below.

3.2.3 Description of Constraint Set.

The constraint set reflects relationships among decision variables and parameters that are imposed by the characteristics of the problem under study.

1) Material Balance.

Equations numbered 2 through 37 of Figure 2.1 are known as material balance equations. They insure that what is shipped equals the various amounts required at deficit ports during the one year planning horizon. Equations (2) through (20) represent material balance equations for domestic deficit or receiver ports. In the example, equation 5 is the material balance equation at deficit port R_4. It states that the amount of rice XP_iR_4 shipped directly from supply port $P_i(i = 1,3,\ldots,7,10,11)$ to deficit port R_4 must equal the demand DR_4 at this port. That is from Table 2.4

$$\sum_i XP_iR_4 = 16000, \qquad i = 1,3,4, \ldots, 7,10,11$$

Equations 21 through 29 and 32 through 35 are material balance equations for international deficit ports while equations 30 and 31 are for international surplus ports. In the example, equation 25 is the material balance equation at the international deficit port P_5. It states that the amount of rice shipped from any foreign port and any local surplus port to port P_5 must equal the demand DP_5 at this port plus the amount to be shipped to deficit ports R_j $(j = 2, \ldots, 8)$ where various amounts are required. That is

$$-\sum_j XP_5R_j + XP_{10}P_5 + XP_{11}P_5 + IP_5 = 30000, \qquad j = 2, \ldots, 8$$

Table 2.5 Notation for the computer printout

1. ROWS (constraints)

   COST = the total transportation cost (does not include material cost)

   MBR_j = material balance at local deficit port j; j = 1,2, ..., 19.

   MBP_i = material balance at international supply port i; i = 1,2, ..., 15.

   MBS_p = material balance at local surplus port S_p; p = 2,3.

   TOTDEM = total deficit.

2. COLUMNS (technological variables)

   XP_iR_j = the amount, in metric tons of rice, to be shipped from the international supply port P_i to deficit port R_j.

   XS_pR_j = the amount, in metric tons of rice, to be shipped from the local surplus port S_p to deficit port R_j

   IP_i = the amount, in metric tons of rice, to be imported from overseas to destination P_i.

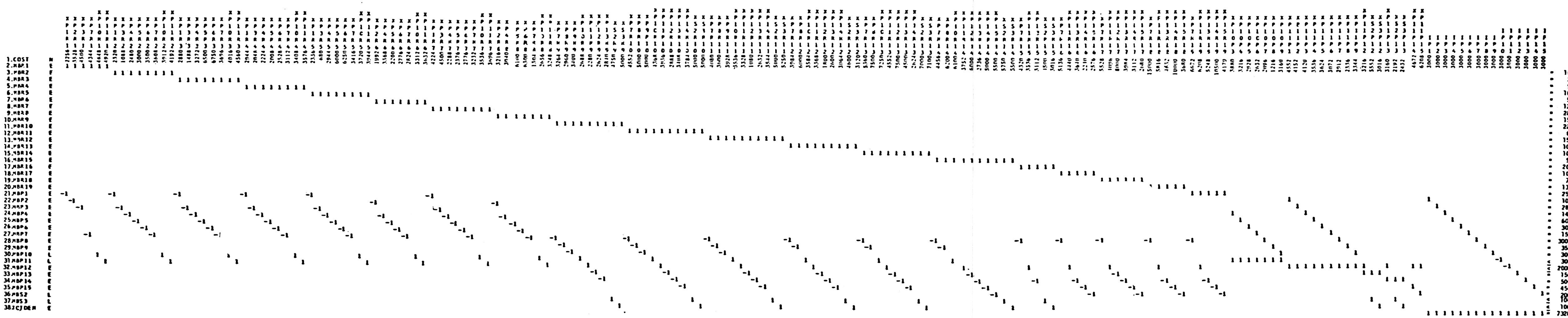


Figure 2.1. A Basic Transporation Model.

In the example, equation 31 is the material balance equation at the international surplus port P_{11}. It states that the amount of rice shipped from surplus port P_{11} to deficit ports R_j (j = 1,2, ..., 19) and P_k (k=1, ..., 9, 12, ..., 15) should not exceed the local surplus available and imports at port P_{11}. That is

$$\sum_j XP_{11}R_j + \sum_k XP_{11}P_k - IP_{11} \leq 200000, \quad j = 1,2, \ldots, 19$$
$$k = 1, \ldots, 9,12, \ldots, 15$$

Equation 36 and 37 are material balance equations for local surplus ports. In the example, equation 36 is the material balance equation at the local surplus port S_2. It states that the amount of rice shipped from local surplus port S_2 to deficit ports R_j (j = 9, ..., 15) and P_k (k = 12,13) should not exceed the local surplus available at S_2. That is

$$\sum_j S_2R_j + \sum_k S_2P_k \leq 10000, \quad j = 9, \ldots, 15$$
$$k = 12,13$$

2) Demand Requirements

Equation numbered 38 in Figure 2.1 states that the total imports equal the total amount of the deficit. That is

$$IP_1 + IP_2 + \ldots + IP_{15} = 732000.$$

3.2.4. Objective Function

The objective function to be satisfied in this problem is the total shipping cost. The total cost is the sum of the individual shipping costs which are proportional to the amount shipped. The shipping cost equation, equation numbered 1 in Figure 2.1, sums up the total domestic shipping costs and the total importing shipping costs.

4. Analysis of Solutions.

Once an optimal solution has been obtained, most computer codes provide the user with a great amount of information that describes in detail the specific values of the optimal solution and its sensitivity to changes in some of the parameters of the original linear programming problem. Typical information available include:

1) Optimal value of the objective function. When the model has been constructed properly, this value is the best solution available.
2) Optimal values of the decisions variables. For each of the decision variables the program specifies its optimal value.
3) Slack variables in the constraints. Normally, a slack variable corresponds to an unused amount of a given resource.
4) Shadow prices for the constraints. The shadow price associated with a given constraint corresponds to the change in the objective function when the original right hand side of the constraint is increased by one unit. Shadow prices usually can be interpreted as marginal costs (for minimizing) or marginal profits (for maximizing). Constraints that have positive slack variables have zero shadow prices.
5) Reduced costs for decision variables. Reduced costs can be interpreted as the shadow prices corresponding to the slack variables of

the constraints. All basic variables have zero reduced costs. The reduced cost associated with a nonbasic variable corresponds to the change in the objective function whenever the value of this nonbasic variable is forced into the solution.

6) Ranges on the coefficients of the objective function. Ranges are given for each decision variable, indicating the lower and upper bound the cost coefficient of the variable can change without changing the current solution (or basis).

7) Ranges on the constraint coefficients of the right hand side. Ranges are given for the right hand side element of each constraint, indicating the lower and upper value the constraint coefficient can change without affecting the feasibility or nonnegativity of the optimal solution.

8) Variable transitions resulting from changes in the coefficients of the objective function. Whenever a coefficient of the objective function is changed beyond the range prescribed above, a change of basis will take place. This element of the output report shows, for each variable, what variable will leave the basis and what new variable will enter the basis if the objective function coefficient of the corresponding variable were to assume a value beyond its current range.

9) Variable transition resulting from changes in the coefficient of the right hand side. Similarly, whenever a coefficient of the right hand side of a constraint is changed beyond the range prescribed above, a change in the current basis will occur. This portion of

the report shows, for each constraint, which variable will leave the basis and which new variable will enter the basis if the right hand side coefficient of the corresponding constraint were to assume values beyond its current range.

In Appendix I an example of these output are presented. The optimum of the linear programming model can be summarized as follows:

Total transportation cost: Rp 3,136,734,000

Domestic allocation activities: Table 2.6

Import allocation activities: Table 2.7

5. The Capacitated Rice Transportation Model

In the Rice Transportation Model we allow the possibility of infinite capacities over all routes. In real life, physical constraints are imposed by the availability of shipping capacities. The shipping capacities may be finite or zero over some or all of the routes. Zero shipping capacity means there are no shipping lines available. In this section, a capacitated transportation model which was discussed in section 2, is implemented. Input data necessary for the capacitated transportation model are presented in Table 2.8. This table represents the availability of the capacities over all of the routes which are related to the basic transportation model. Routes which are not stated in Table 2.8 are assumed to have zero shipping capacities. Shipping capacities over import routes are assumed to be infinite. We note from the material balance equation 6 in Figure 2.1 and the shipping capacities data Table 2.8, there are no shipping lines available to destination point R_5 (Bengkalis). In order to meet the demand at Point R_5 a charter ship is allowed. The charter route selected was the cheapest route. Based on domestic shipping costs Table 2.3 route (P_3,R_5) is the cheapest route with current shipping costs of Rp 680 per metric ton. The charter cost per metric ton is assumed to be double, Rp 1360, with a shipping capacity of 5000 metric tons which equals the optimum activity XP_3R_5 (Table 2.6).

The Capacitated Rice Transportation Model is developed by simply adding the shipping capacities as upper bound constraints on the Basic Transportation Model. These capacity constraints are added on the activities XP_iR_j and can be stated as follows:

$$XP_iR_j \leq U_{ij}$$

where XP_iR_j = the amount, in metric tons of rice, to be shipped from port P_i to destination R_j

U_{ij} = the capacity or upper bound for shipment from origin P_i to destination R_j.

For example, the activity XP_1R_1 which is the amount, in metric tons of rice, to be shipped from port P_1 (Medan) to destination R_1 (Banda Aceh), the capacity constraint is 46800 metric tons. This constraint can be stated as:

$$XP_1R_1 \leq 46800$$

These constraints are shown in the computer printout (Appendix II) in the Bound's section. The optimal solution of the capacitated transportation model can be summarized as follows (see also Appendix II):

Total transportation cost: Rp 3,259,970,880

Domestic allocation activities: Table 2.9

Import activities: Table 2.10

Note this solution costs more Rp 123,236,880 than the uncapacitated solution.

Table 2.6 Domestic shipping activities. (One year planning horizon)

From	To	Activity (metric ton)	Notation
Medan	Banda Aceh	10,000	XP_1R_1
Dumai	Bagansiapi	2,000	XP_3R_2
Dumai	Pakanbaru	5,000	XP_3R_3
Surabaya	Tanjung Pinang	16,000	$XP_{11}R_4$
Dumai	Bengkalis	5,000	XP_3R_5
Surabaya	Bengkulu	12,000	$XP_{11}R_6$
Surabaya	Jambi	28,000	$XP_{11}R_7$
Surabaya	Pajang	15,000	$XP_{11}R_8$
Surabaya	Banjarmasin	22,000	$XP_{11}R_9$
Surabaya	Tarakan	6,000	$XP_{11}R_{10}$
Surabaya	Samarinda	7,000	$XP_{11}R_{11}$
Surabaya	Palu	10,000	$XP_{11}R_{12}$
Surabaya	Poso	10,000	$XP_{11}R_{13}$
Surabaya	Kendari	9,000	$XP_{11}R_{14}$
Surabaya	Kupang	10,000	$XP_{11}P_{15}$
Ampenan	Kupang	10,000	XS_3R_{15}
Surabaya	Ternate	10,000	$XP_{11}R_{16}$
Surabaya	Sorong	7,000	$XP_{11}R_{17}$
Surabaya	Biak	13,000	$XP_{11}R_{18}$
Surabaya	Ambon	25,000	$XP_{11}R_{19}$
Semarang	Cirebon	30,000	$XP_{10}P_8$
Benoa	Ujungpandang	10,000	XS_2P_{13}
Balikpapan	Samarinda	8,000	$XP_{12}R_{11}$

Table 2.7. Importing activities. (One year planning horizon)

Ports	Activity (metric ton)	Notation
Medan	110,000	IP_1
Padang	28,000	IP_2
Dumai	26,000	IP_3
Palembang	60,000	IP_4
Pangkal Pinang	30,000	IP_5
Tanjung Pandan	15,000	IP_6
Jakarta	300,000	IP_7
Cirebon	5,000	IP_8
Pontianak	30,000	IP_9
Balikpapan	23,000	IP_{12}
Ujungpandang	40,000	IP_{13}
Bitung	45,000	IP_{14}
Jayapura	20,000	IP_{15}

Table 2.8 Shipping capacity

From		To		Capacity (tons/trip)	Frequency per year	Total capacity per year (tons)
Medan	P_1	Banda Aceh	R_1	1,560	30	46,800
Surabaya	P_{11}	Bagansiapi	R_2	1,660	16	26,560
Dumai	P_3	Pakanbaru	R_3	1,020	20	20,400
Jakarta	P_7	Pakanbaru	R_3	2,281	16	36,496
Semarang	P_{10}	Pakanbaru	R_3	1,894	16	30,304
Semarang	P_{10}	Tanjung Pinang	R_4	1,500	12	18,000
Padang	P_2	Bengkulu	R_6	750	16	12,000
Jakarta	P_7	Bengkulu	R_6	2,281	16	36,496
Surabaya	P_{11}	Bengkulu	R_6	11,078	12	132,936
Palembang	P_4	Jambi	R_7	11,078	12	132,936
Surabaya	P_{11}	Jambi	R_7	575	16	9,200
Surabaya	P_{11}	Pajang	R_8	2,345	13	30,485
Jakarta	P_7	Banjarmasin	R_9	978	30	29,340
Semarang	P_{10}	Banjarmasin	R_9	2,927	16	46,832
Surabaya	P_{11}	Banjarmasin	R_9	1,422	20	28,440
Surabaya	P_{11}	Tarakan	R_{10}	3,780	16	60,480

Table 2.8 (continued)

From		To		Capacity (tons/trip)	Frequency per year	Total capacity per year (tons)
Jakarta	P_7	Padang	P_2	1,630	52	84,760
Medan	P_1	Dumai	P_3	14,773	21	310,233
Jakarta	P_7	Palembang	P_4	1,747	20	34,940
Jakarta	P_7	Cirebon	P_8	4,428	20	88,560
Jakarta	P_7	Pontianak	P_9	4,149	15	62,235
Jakarta	P_7	Pontianak	P_9	1,613	35	56,455
Jakarta	P_7	Balikpapan	P_{12}	4,307	15	64,605
Jakarta	P_7	Ujungpandang	P_{13}	14,332	12	171,984
Jakarta	P_7	Ujungpandang	P_{13}	3,484	24	83,616
Surabaya	P_{11}	Medan	P_1	12,599	16	201,584
Surabaya	P_{11}	Padang	P_2	11,078	12	132,936
Surabaya	P_{11}	Palembang	P_4	8,543	16	136,688
Surabaya	P_{11}	Tanjung Pandan	P_6	980	16	15,680
Surabaya	P_{11}	Jakarta	P_7	5,476	8	43,808
Surabaya	P_{11}	Cirebon	P_8	1,558	8	12,464

Table 2.8 (continued)

From		To		Capacity (tons/trip)	Frequency per year	Total capacity per year (tons)
Surabaya	P_{11}	Samarinda	R_{11}	5,607	16	89,712
Jakarta	P_7	Palu	R_{12}	10,959	13	142,467
Surabaya	P_{11}	Palu	R_{12}	3,168	15	47,520
Surabaya	P_{11}	Palu	R_{12}	8,530	12	102,360
Ujungpandang	P_{13}	Poso	R_{13}	704	13	9,152
Bitung	P_{14}	Poso	R_{13}	2,337	16	37,392
Surabaya	P_{11}	Kendari	R_{14}	2,337	16	37,392
Surabaya	P_{11}	Kupang	R_{15}	7,436	13	96,668
Benoa	S_2	Kupang	R_{15}	6,864	12	82,368
Ampenan	S_3	Kupang	R_{15}	5,336	13	69,368
Surabaya	P_{11}	Ternate	R_{16}	4,306	16	68,896
Ujungpandang	P_{13}	Sorong	R_{17}	5,476	8	43,808
Jayapura	P_{15}	Biak	R_{18}	4,200	10	42,000
Surabaya	P_{11}	Ambon	R_{19}	8,624	16	137,984
Jakarta	P_7	Medan	P_1	16,878	21	354,438
Jakarta	P_7	Padang	P_2	2,110	30	63,300
Jakarta	P_7	Padang	P_2	1,551	16	24,816

Table 2.8 (continued)

From		To		Capacity (tons/trip)	Frequency per year	Total capacity per year (tons)
Surabaya	P_{11}	Pontianak	P_9	1,085	16	17,360
Surabaya	P_{11}	Balikpapan	P_{12}	7,480	13	108,580
Surabaya	P_{11}	Ujungpandang	P_{13}	1,982	26	51,532
Surabaya	P_{11}	Ujungpandang	P_{13}	4,542	15	68,130
Surabaya	P_{11}	Bitung	P_{14}	4,612	16	73,792

*Source: Bulog 1974.

Table 2.9 Domestic shipping activities

From	To	Activity (metric tons)	Shipment capacity (metric tons)	Notation
Medan	Banda Aceh	10,000	46,800	XP_1R_1
Surabaya	Bagansiapi	2,000	26,560	$XP_{11}R_2$
Semaraug	Pakanbaru	5,000	30,304	$XP_{10}R_3$
Semarang	Tanjung Pinang	16,000	18,000	$XP_{10}R_4$
Dumai	Bengkalis	5,000	5,000	XP_3R_5
Surabaya	Bengkulu	12,000	132,936	$XP_{11}R_6$
Palembang	Jambi	18,800	132,936	XP_4R_7
Surabaya	Jambi	9,200	9,200	$XP_{11}R_7$
Surabaya	Pajang	15,000	30,485	$XP_{11}R_8$
Semarang	Banjarmasin	9,000	46,832	$XP_{10}R_9$
Surabaya	Banjarmasin	13,000	28,440	$XP_{11}R_9$
Surabaya	Tarakan	6,000	60,480	$XP_{11}R_{10}$
Surabaya	Samarinda	15,000	89,712	$XP_{11}R_{11}$
Surabaya	Palu	10,000	149,880	$XP_{11}R_{12}$
Bitung	POSO	10,000	37,392	$XP_{14}R_{13}$
Surabaya	Kendari	9,000	37,392	$XP_{11}R_{14}$
Benoa	Kupang	10,000	82,368	XS_2R_{15}
Ampenan	Kupang	10,000	69,368	XS_3R_{15}
Surabaya	Ternate	10,000	68,896	$XP_{11}R_{16}$
Ujungpandang	Sorong	7,000	43,808	$XP_{13}R_{17}$
Jayapura	Biak	13,000	42,000	$XP_{15}R_{18}$
Surabaya	Ambon	25,000	137,984	$XP_{11}R_{19}$

Table 2.9 (continued)

From	To	Activity (metric tons)	Shipment capacity (metric tons)	Notation
Surabaya	Tanjung Pandan	15,000	15,680	$XP_{11}P_6$
Surabaya	Jakarta	43,808	43,808	$XP_{11}P_7$
Surabaya	Cirebon	12,464	12,464	$XP_{11}P_8$
Surabaya	Ujung Pandang	2,528	260,353	$XP_{11}P_{13}$

Table 2.10 Importing activities

Ports	Activity	Notation
Medan	110,000	IP_1
Padang	28,000	IP_2
Dumai	19,000	IP_3
Palembang	78,800	IP_4
Pangkal Pinang	30,000	IP_5
Jakarta	256,192	IP_7
Cirebon	22,536	IP_8
Pontianak	30,000	IP_9
Balikpapan	15,000	IP_{12}
Ujungpandang	54,472	IP_{13}
Bitung	55,000	IP_{14}
Jayapura	33,000	IP_{15}

CHAPTER 3

SHIPPING SCHEDULE

1. Introduction

This chapter deals with determining the actual shipping schedule from the proposed optimal shipping pattern obtained in Chapter 2. The network flows are shown in Figure 3.1. The problem treated here is to determine the number of shiploads and when they should be scheduled to incorporate the variations of domestic supply, seasonal domestic procurement and demand fluctuations.

The objective is to minimize setup costs and grain losses, subject to: (1) number of ship trips available, (2) warehouse capacity, (3) seasonal domestic supply, (4) demand fluctuations and (5) loading and unloading capacities. As mentioned in Chapter 1, this shipping schedule is solved by an iterative procedure to determine a near optimal schedule.

2. Rice Shipping Schedule

Having determined the optimal shipping routes, scheduling decisions must be made within the shipping capacity constraints and the frequency of trips in order to meet the various demands in each period (month). The problem is to find the amount of rice to be shipped from supply ports to destination ports (or to be received at importing ports), which constitutes the optimal capacitated shipment pattern, and to minimize the number of shipments during a planning horizon of one year. Also we wish to minimize the setup costs and grain losses subject to the constraints:

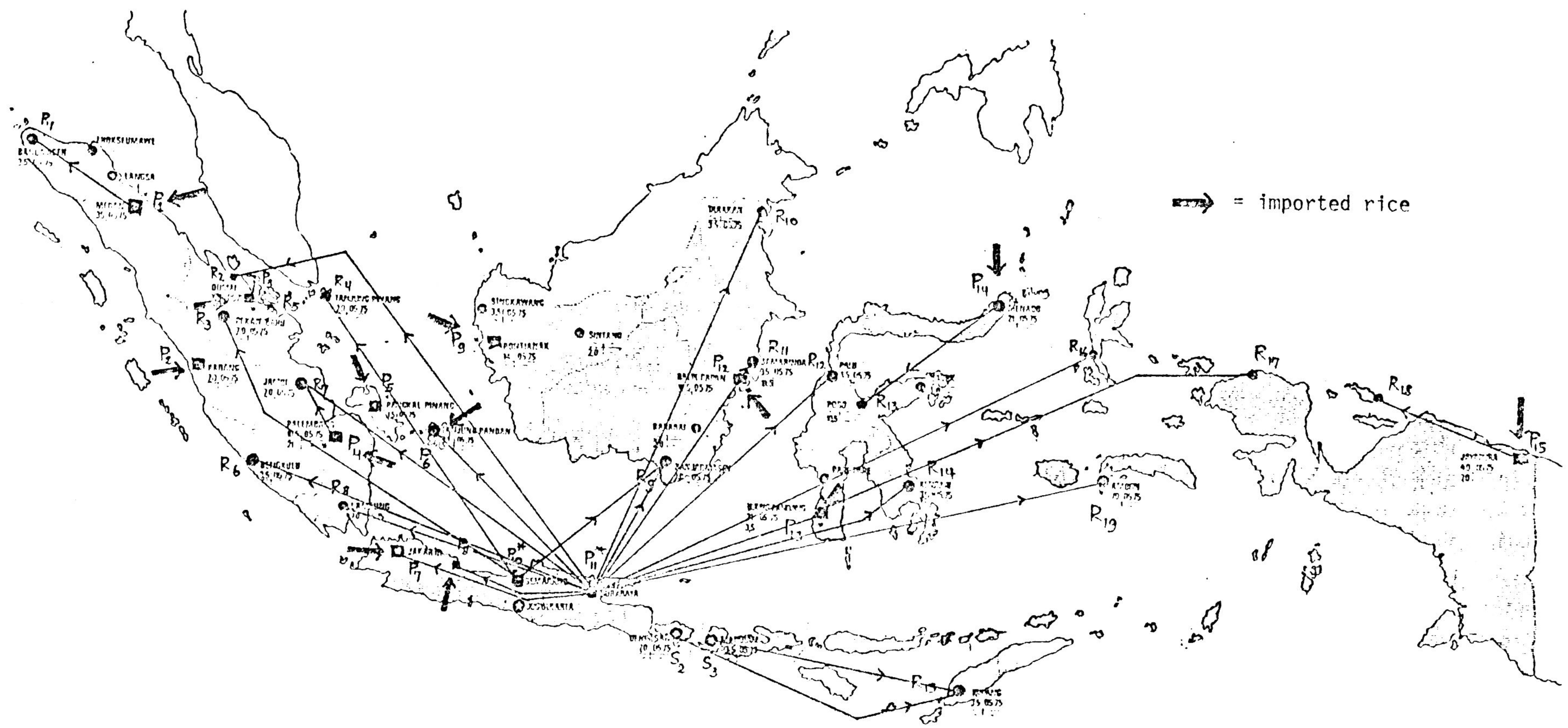


Figure 3.1 The Network Flows of Capacitated Transportation Model.

(1) Number of ship trips available

(2) Warehouse capacity

(3) Demand fluctuations

(4) Seasonal domestic supply

(5) Loading and unloading capacity

The setup costs may include clerical and administrative costs, preparation costs, labor setup costs and other pertinents costs.

3. Description of Constraint Set

3.1. Number of ship trips available.

There are constraints imposed due to the limitation of the number of trips from supply ports to deficit ports during a time period. Data of number of ship trips available are shown in Table 2.8 and Table 3.1. Each shipment should not exceed the predetermined capacity per trip in the respective routes. The frequency of shipments should not exceed the predetermined value available during the planning horizon considered.

3.2 Warehouse capacity.

This constraint indicates that in each port, the amount of inventory at the end of any month should not exceed the warehouse capacity. Data of warehouse capacity for each port is presented in Table 3.1.

3.3 Demand fluctuation.

Demand requirements fall into two categories: 1) the amount guaranteed to government employees and the armed forces during the planning period and 2) the requirement that some rice is to be released into the open market to stabilize prices. The last category is dependent upon the rice production and inter-regional rice trading system. Monthly demand forecast data are presented in Table 3.1. These data are based on the latest consumption requirements of government employees and the armed forces and on experience with regard to the crop condition, current price of rice and the inter-regional rice trading system. This constraint ensures that the demand requirement for each period (month) will be met.

3.4 Seasonal domestic supply.

Rice is consumed uniformly during the year but produced seasonally. In some areas one crop is raised, where the rice is grown in the wet season and is harvested at the end of the season. Other areas two crop are raised, where the main crop is grown during the monsoon and a second smaller crop is grown during the dry season. The fields are irrigated during this time.

Most of the rice produced in Indonesia is grown by a large number of small farmers. About 75 percent of the total rice crop is produced in the wet season on wet fields. Rice is a subsistence crop for small farmers where only about 25 percent of the crop is sold and moves into the open market.

There are numerous varieties of rice produced (wet-land, dry-land etc) at various times of the year, in different areas. The harvesting seasons are shown in Figure 3.2. As a result, not all of the rice in Indonesia is ready for market at a single time of the year. In well irrigated areas, two or even three crops a year are grown. Given that facilities are available for shipping post harvest surpluses, pre-harvest

Table 3.1. Availability of ships, warehouse capacity, initial inventory and demand fluctuation data.

Ports	Warehouse capacity	Initial stock	Demand												Shipment		
			Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	From	Capacity per trip	Number of trips
R_1	3500	1050	960	970	890	840	640	650	760	810	820	810	890	960	P_1	1560	30
R_2	3500	1050	200	190	150	160	100	100	70	90	230	240	210	260	P_{11}	1660	16
R_3	7000	2100	610	360	240	180	280	230	340	380	430	530	680	740	P_{10}	1894	16
R_4	7000	2100	1360	1710	1480	1230	790	850	1010	780	1040	1150	2320	2280	P_{10}	1500	12
R_5	3500	1050	420	390	310	350	210	310	310	280	460	570	390	1000	P_3	500	10
R_6	3500	1050	1000	1040	1040	1230	940	910	870	950	870	1070	1080	1000	P_{11}	11078	12
R_7	7000	2800	2740	2950	2990	2900	2080	1400	1680	2440	2200	2530	3080	1010	P_{11}	575	16
															P_4	11078	12
R_8	7000	2100	1390	830	970	850	600	670	720	750	1330	2250	2760	1880	P_{11}	2345	13
															P_{11}	1422	20
R_9	14000	4200	2430	2210	1950	2020	1560	1530	1320	1150	1490	2050	1920	2370	P_{10}	2927	16
R_{10}	3500	1050	730	610	390	620	580	570	380	340	640	470	310	360	P_{11}	3750	16
R_{11}	14000	4200	2060	1230	1130	7880	1620	1030	1140	1130	900	870	740	1270	P_{11}	5607	16
R_{12}	3500	1050	960	940	1110	760	690	750	630	640	630	700	1100	1090	P_{11}	8530	12
R_{13}	10500	3150	1100	1040	1010	760	690	650	630	640	640	610	1210	1020	P_{14}	2337	16
R_{14}	3500	1050	980	940	840	720	630	740	820	690	610	640	650	740	P_{11}	2337	16
															S_2	6864	12
R_{15}	7000	2100	1430	1370	1520	1530	1580	1590	1600	2010	1920	1860	1810	1780	S_3	5336	13
R_{16}	3500	1050	960	950	880	820	830	780	840	790	720	770	800	860	P_{11}	4306	16
R_{17}	3500	1050	740	570	410	360	400	350	410	470	670	790	850	980	P_{13}	5476	8
R_{18}	7000	2100	1180	1060	1050	1140	1010	1000	980	1060	1080	1180	1180	1000	P_{15}	4200	10
R_{19}	7000	2100	2050	2140	2330	2100	2280	2370	2020	1760	2370	1910	1760	1910	P_{11}	8624	16
P_1	45500	13650	7820	7110	8940	8710	8920	9230	7940	8560	8260	8120	7810	8580	Imports	-	-
P_2	7000	3500	3250	2030	1970	1970	1480	1510	1720	1620	1710	2690	3700	4350	Imports	-	-
P_3	10500	3150	1420	1440	1280	1210	1020	910	910	910	1100	1200	1300	1300	Imports	-	-
P_4	24500	8400	7600	5640	5370	5620	4780	2920	5720	2910	3530	3900	5070	6140	Imports	-	-
P_5	3500	2500	2320	2500	2750	3120	2420	2920	2710	2430	2490	1790	2080	2470	Imports	-	-
P_6	3500	1750	1030	1170	1210	1440	1060	1130	40	1630	1010	1060	1680	1540	P_{11}	980	16
P_7	252000	75600	43030	28180	23130	19620	15900	16490	17820	22350	21510	28200	30640	33130	P_{11}	5476	8
															Imports		
P_8	21000	6300	5070	1750	2860	2730	1440	1560	1780	3510	3480	3430	3700	3690	P_{11}	1558	8
															Imports		
P_9	14000	4200	3810	3880	2440	3630	2420	1170	2180	1540	3170	2410	2070	1280	Imports	-	-
P_{12}	10500	3150	1500	1090	1370	1460	1340	1050	1170	990	930	970	1540	1590	Imports	-	-
P_{13}	24500	8400	6800	3850	4450	4620	3780	3170	4190	4090	4090	3760	3800	3400	P_{11}	4542	15
															Imports		
P_{14}	28000	8400	3560	4620	3460	4430	3730	2740	3670	3940	3530	3420	3740	4160	Imports	-	-
P_{15}	19500	5850	1020	2620	1320	1570	2020	1770	2600	1720	1260	1480	1650	970	Imports	-	-

*Source: Bulog 1974.

shortages in some areas can be avoided.

In the areas where water is available part of the year or not available at all, the crops are subject to seasonal rainfall. The yield is generally concentrated in one main crop or at most two crops. The two crops are the main season crop and the smaller or secondary dry season crop.

The differences of climates, soil conditions and supply of water in various provinces also affects the timing of harvests, number of harvests and relative sizes of crops through one year.

In accordance with the various rice harvesting patterns the planning horizon considered is from April to March of the subsequent year. It may be recalled that the government procures rice from domestic markets at prices (floor prices) that would be sufficient to encourage the farmers to increase production. The government handles most of its procurement during the three month of May, June and July, right after the main crop harvest, when prices are usually lower than floor prices. Seasonal procrument estimates are shown in Figure 3.3. Monthly procurement availability is shown in Table 3.2. This constraint insures that the total amount of rice shipped from any surplus port will not exceed the available supply, in a corresponding period.

3.5 Loading and Unloading Capacity

Constraints on port capacity are necessary to ensure that realistic schedules can be satisfied. These constraints may be a function of the union working rules, labor forces, crane capacities, or any set of operations. In real life, the problem of unloading imported rice plays an

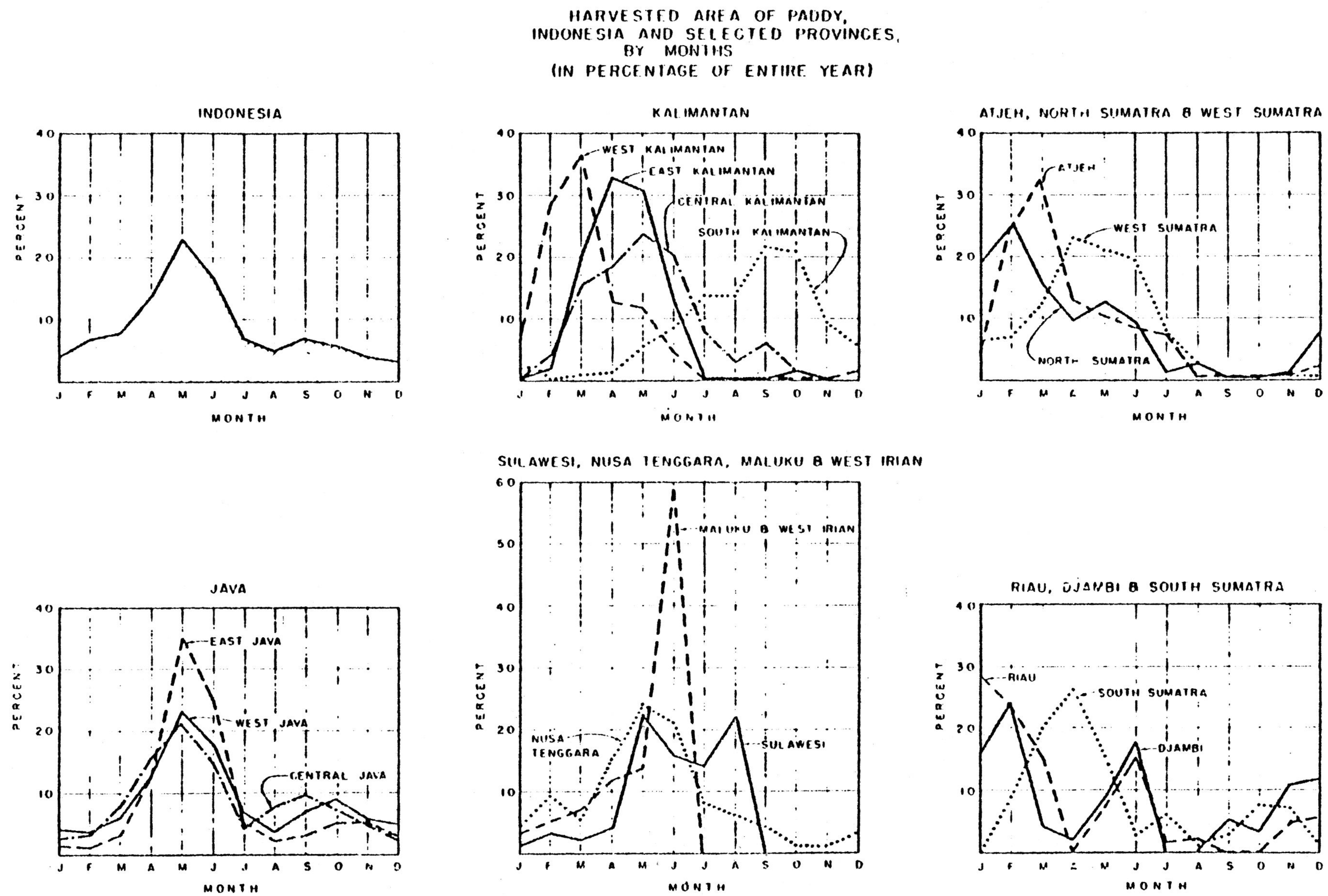


Figure 3.2 Harvesting Seasons

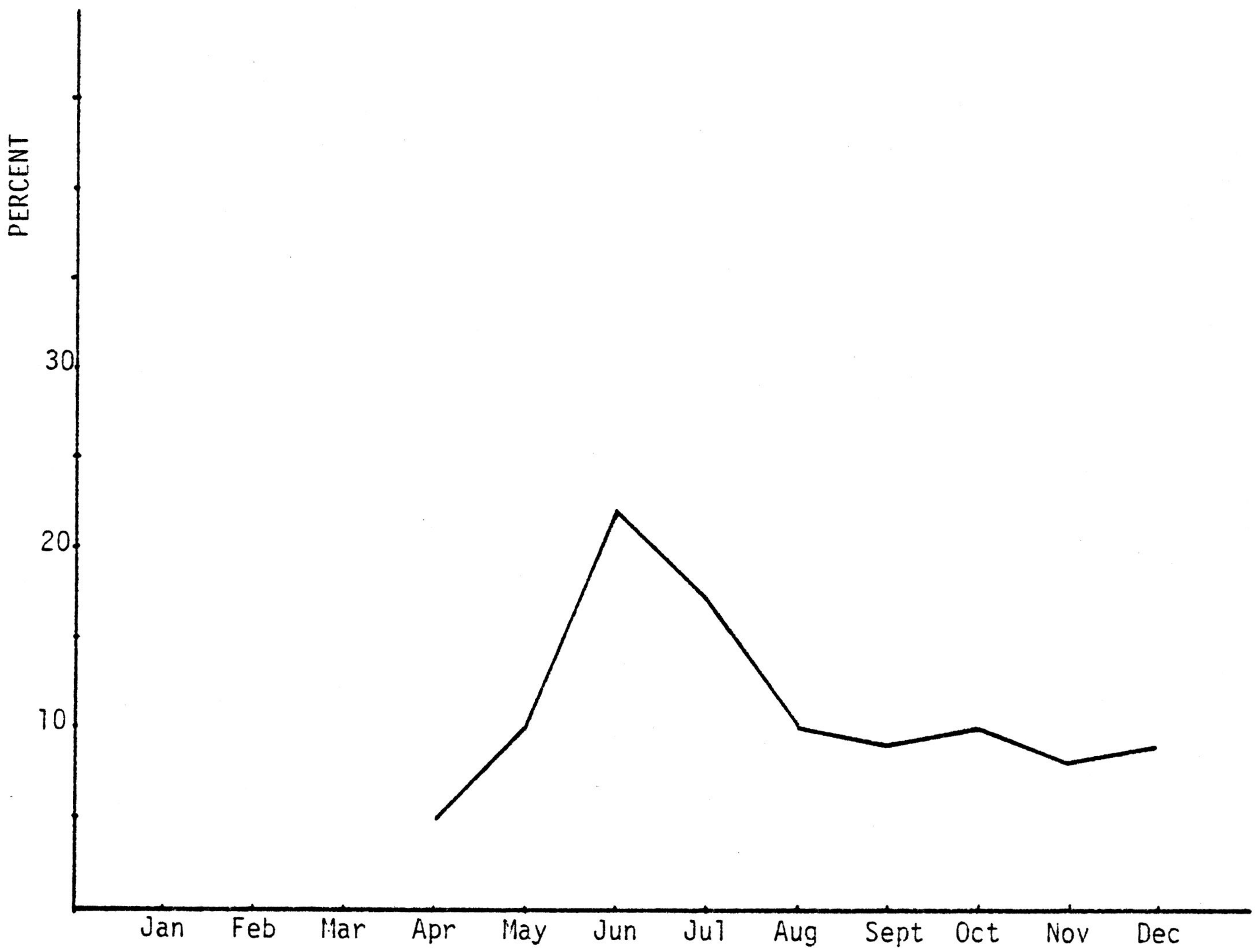


Figure 3.3 Seasonal Procurement

Table 3.2. Monthly domestic rice procurement (in 100 metric tons)

Ports	A	M	J	J	A	S	O	N	D	J	F	M	Total
P_{11}	100	200	440	340	200	180	200	160	180	0	0	0	2000
P_{10}	15	30	66	51	30	27	30	24	27	0	0	0	300
S_2	5	10	22	17	10	9	10	8	9	0	0	0	100
S_3	5	10	22	17	10	9	10	8	9	0	0	0	100

*Source: Bulog 1974.

important role. Overtime loading and unloading activities either in ports or warehouses is permitted around the clock. Because of the high demurrage cost, the government is willing to pay this overtime costs. The handling capacity for the main ports are estimated at about 1000 to 2500 metric tons per day. For deficit ports they are estimated to be about 500 metric tons per day. Loading and unloading data are presented in the last column of Table 3.3. This constraint ensures that any handling activity (onloading or offloading) does not take more than 25 days, the number of working days in a month.

4. The solution

The distribution program can be divided into two groups, they are: 1) Domestic scheduling and 2) Imports scheduling. Both domestic and import scheduling are shown in Table 3.3, 3.4 and 3.5. The optimal network flows of the capacitated transportation model in Figure 3.1 show that several importing ports were also supplied from the surplus port P_{11}. There were two activities at these importing ports, interdomestic port shipping schedules and importing schedules. Therefore the rice shipping schedules from surplus port P_{11} to the corresponding deficit ports is a good example of the computation procedure, which is presented in Table 3.3. Recall that sufficient number of ships are available from overseas hence the ship capacity constraints can be neglected.

4.1 Domestic scheduling.

1) To summarize the solution set up a table such as Table 3.3

The first row of the table corresponds to the surplus port P_{11} activities during the twelve month planning period and the other rows correspond to various deficit port activities. The rows are divided into cells corresponding to the number of months in the planning period. Activities in the cells corresponding to the surplus rows include:

a) The amount of supply available via production and procurement in the corresponding month is presented in the first row of the cell.

b) The amount of inventory at the end of the corresponding month after supplying the deficit ports is presented in the second row of the cell.

Activities in the cells corresponding to the deficit rows include:

a) The demand in the corresponding month is presented in the first row of the cell.

b) The amount of inventory at the end of the corresponding month is presented in the second row of the cell.

c) The amount of rice to be shipped from the local surplus port P_{11} in the corresponding month, in order to meet the demand in the following month, is presented in the third row of the cell. The (-) sign in the third row of the cells corresponds to the importing port, P_k, and indicates the amount of rice to be shipped to the corresponding deficit port, R_j. For example, the activities of shipping schedule at port P_{13} in the first period (April):

   Initial inventory = 8400 metric tons

   Demand requirement = 6800 metric tons

   The amount to be shipped from port P_{13} to port R_{17} in this period is 3760 metric tons. The amount to be received from imports in this period is 26660 metric tons. Inventory at the end of this period is 24500 metric tons. Note, that $XP_{13}R_{17}$ = 7000 metric tons is the total amount of rice to be shipped from P_{13} to R_{17} in the one year plan and is indicated in the second column from the right in Table 3.3 with a *.

d) The fourth row of the cells corresponds to the deficit ports R_j and indicates the amount of rice to be shipped from importing or surplus ports in the corresponding month, in order to meet demand in the following month. The fourth row of the cells corresponds to the importing ports P_k, and indicates the amount of rice to be received in the corresponding month.

It is assumed that the rice will be received by the corresponding deficit ports in the beginning of the subsequent corresponding month. The time required for shipment from supply ports or overseas to any destination port normally does not exceed one month.

e) The number of ship trips available during the corresponding month is presented in the subcell in the upper right corner.

2) Additional data is added to Table 3.3, such as warehouse capacity, initial inventory (which is the carry over inventory), domestic supplies available, demand requirements, ships available etc. We calculate the amount of inventory at the end of the first month (April) for each port and put into the second row of each cell.

3) Among the deficit/receiver ports, we note the ports which do not meet the demands in the following month due to insufficient ending inventory. For example deficit port R_8:

Initial inventory: 2100 tons

Demand requirement (April): 1390 tons

Inventory at the end of this period: 2100 - 1390 = 710 tons

Demand in the following month: 830 tons

The amount of the ending inventory (710 tons) does not meet the demand in the following month (830 tons), hence a shortage.

4) Among the ports in (3) of which there are 10, R_6, R_7, R_8, R_9, R_{10}, R_{12}, R_{14}, R_{16}, R_{19}, P_6, we note the ports which received rice from only domestic surplus ports (see Table 2.9, 2.10) there are R_6, R_8, R_9, R_{10}, R_{12}, R_{14}, R_{16}, R_{19}, P_6.

5) Also note the ports which have binding capacity constraints. There are only two, R_7 and P_6.

For example, the route (P_{11}, R_7) is bounded by its shipping capacity of (9200 tons) which is less than its total required shipments (28000 tons). As a result of the amount of rice to be shipped from surplus port P_{11} to deficit port R_7 in each period (month) equals the shipping capacity in the corresponding period. The ships are full and there is still a deficit for R_7. This deficiency is fulfilled by shipping from supply port P_4 as indicated by the LP solution. An example of the solution obtained in the sixth period (Sept.), for row R_7:

The amount of rice to be shipped from P_{11} = 1150 tons

The amount of rice to be shipped from P_4 = 7040 tons

Inventory at the end of this period = 490 tons

The minimum amount of rice to be shipped from P_{11} to the ports noted

(4), in the first period (April), should at least meet the demand requirements in the following month (May).

6) To obtain the actual shipping schedule 1) we fill up the available ship capacity until the shipment is completed, e.g if 20,000 tons are to be shipped and we have 4 ships/year each with 20,000 ton capacity we put the entire load on the first ship. (2) If all constraints are satisfied this is the shipping schedule, if not, e.g warehouse capacity is only 15,000 tons, we reduce the load until the warehouse capacity constraint is satisfied and send the rest on the next ship. In this case we send 15,000 tons on the first ship and 5000 tons on the second ship. We repeat this process until all constraints are satisfied, warehouse capacity unloading and loading capacity, rice supply, demand and number of ships available.

It should be noted that in Table 3.4 and 3.5 the (-) sign in the first row of cells, corresponds to supply ports which indicates the demand in the corresponding month. Also the last row of those cells represents the amount of rice to be received from imports in the corresponding month.

4.2. Imports scheduling.

The fourth row of each cell for the importing ports P_i (i = 1, ..., 9, 12, ..., 15) in Table 3.3, 3.4, and 3.5 represents import scheduling which is the amount of imported rice to be received during the corresponding period (month).

It is assumed that enough ships are available from overseas and the constraint can be neglected. Thus, the import scheduling is determined with the following constraints: 1) the demand of the importing ports plus the amount needed to be shipped on to the other deficit ports, 2) the unloading-loading capacity and 3) the warehouse capacity. These constraints are satisfied in the same iterative manner as 6) above.

It is interesting to note that the scheduling is very sensitive to the initial inventory of the deficit ports R which received rice from only domestic surplus ports. If the initial inventory does not meet the demand requirement in the following period, the optimal capacitated shipping pattern may be violated since direct imports to the corresponding ports cannot be made. To overcome this difficulty, the necessary adjustments of the initial inventory are made by physically adjusting and shipping the carry over inventory to the various ports before the season starts and the planning model is used. This transfer is done so the constraints in the planning period are satisfied. We can determine the quantities to be shifted from the LP solution and Table 3.3, 3.4 and 3.5. In our problem, this situation did not occur.

The summary of the schedules are shown in Table 3.6 and 3.7.

Table 3.3 Ship schedule from port P_{11}.

Ports	Warehouse capacity	Initial stock	Apr	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total activities	Shipment capacity per trip	Number of trips	Total shipment capacity		Loading & unloading capacity/day
Surplus P_{11}	67500		10000 0	20000 0	44000 0	34000 22115	20000 29759	18000 18751	20000 31561	16000 31208	18000 29643	0 21553	0 9464	0 0	200,000					2000
Deficit R_2	3500	1050	200 [1] 850 -	190 [1] 660 -	150 [2] 510 -	160 [1] 350 -	100 [1] 250 -	100 [2] 150 2000	70 [1] 2080 -	90 [1] 1990 -	230 [2] 1760 -	240 [1] 1520 -	210 [1] 1310 -	260 [2] 1050 -	2000	1660	16	26560		500
R_6	3500	1050	1000 [1] 50 1200	1040 [1] 210 2274	1040 [1] 1444 -	1230 [1] 214 4226	940 [1] 3500 -	910 [1] 2590 -	870 [1] 1720 -	950 [1] 770 3600	870 [1] 3500 700	1070 [1] 3130 -	1080 [1] 2050 -	1000 [1] 1050 -	12000	11078	12	132936		500
R_7	7000	2800	2740 [1] 60 575 9300*	2950 [1] 6985 575	2990 [2] 4570 1150	2900 [2] 2820 575	2080 [1] 1315 575	1400 [2] 490 1150 7040*	1680 [1] 7000 575	2440 [1] 5135 575	2200 [2] 3510 1150	2530 [1] 2130 575 2460*	3080 [1] 2085 575	1010 [2] 1650 1150	28000	575 *11078	16 12	9200 132936	$XP_{11}R_7$ = 9200 XP_4R_7 =18800	500
R_8	7000	2100	1390 [1] 710 220	830 [1] 100 2345	970 [1] 1475 2345	850 [1] 2970 2345	600 [1] 4715 2345	670 [1] 6390 1330	720 [1] 7000 -	750 [1] 6250 -	1330 [1] 4920 2345	2250 [1] 5015 1725	2760 [1] 3980 -	1880 [1] 2100 -	15000	2345	13	30485		500
R_9	14000	4200	2430 [1] 1770 1400	2210 [1] 960 1422	1950 [1] 432 1422 2927*	2020 [1] 2761 1422	1560 [1] 2623 1422	1530 [2] 2515 2844	1320 [2] 4039 2844	1150 [2] 5733 224 2927*	1490 [2] 7394 - 2927*	2050 [2] 8271 - 219*	1920 [2] 6570 -	2370 [2] 4200 -	22000	1422 *2927	20 16	28440 46832	$XP_{11}R_9$ =13000 $XP_{10}R_9$ = 9000	500
R_{10}	3500	1050	730 [1] 320 425	610 [1] 135 300	390 [2] 45 2484	620 [1] 1909 -	580 [1] 1329 -	570 [2] 759 -	380 [1] 379 2791	340 [1] 2830 -	640 [2] 2190 -	470 [1] 1720 -	310 [1] 1410 -	360 [1] 1050 -	6000	3750	16	60000		500
R_{11}	14000	4200	2060 [1] 2140 -	1230 [1] 910 300	1130 [2] 80 5600	1880 [1] 3800 -	1620 [1] 2180 -	1030 [2] 1150 5600	1140 [1] 5610 -	1130 [1] 4480 -	900 [2] 3580 -	870 [1] 2710 -	740 [1] 1970 3500	1270 [2] 4200 -	15000	5607	16	89712		500
R_{12}	3500	1050	960 [1] 90 1000	940 [1] 150 1000	1110 [1] 40 4220	760 [1] 3500 -	690 [1] 2810 -	750 [1] 2060 -	630 [1] 1430 -	640 [1] 790 -	630 [1] 160 3780	700 [1] 3240 -	1100 [1] 2140 -	1090 [1] 1050 -	10000	8530	12	102360		500
R_{14}	3500	1050	980 [1] 70 1000	940 [1] 130 730	840 [2] 20 2337	720 [1] 1637 2337	630 [1] 3344 -	740 [2] 2604 -	820 [1] 1784 -	690 [1] 1094 -	610 [2] 484 2596	640 [1] 2440 -	650 [1] 1790 -	740 [2] 1050 -	9000	2337	16	37392		500
R_{16}	3500	1050	960 [1] 90 1000	950 [1] 140 760	880 [2] 20 4300	820 [1] 3500 -	830 [1] 2670 -	780 [2] 1890 -	840 [1] 1050 -	790 [1] 260 3940	720 [2] 3480 -	770 [1] 2710 -	800 [1] 1910 -	860 [2] 1050 -	10000	4306	16	68896		500
R_{19}	7000	2100	2050 [1] 50 2200	2140 [1] 110 2280	2330 [2] 60 8620	2100 [1] 6580 -	2280 [1] 4300 -	2370 [2] 1930 7090	2020 [1] 7000 -	1760 [1] 5240 -	2370 [2] 2870 -	1910 [1] 960 4810	1760 [1] 4010 -	1910 [2] 2100 -	25000	8624	16	137984		500
P_7	252000	75600	43030 [1] 32570 - -	28180 [1] 54390 5476 50000	23130 [1] 36736 5476 -	19620 22592 - 50000	15900 [1] 56692 5476 -	16490 [1] 95678 5476 50000	17820 83334 - -	22350 [1] 110984 5476 50000	21510 [1] 94950 5476 -	28200 128418 - 56192	30640 [1] 97778 5476 -	33130 [1] 70124 5476 -	300000	5476	8	43808	$XP_{11}P_7$ =43808 IP_7 =256192	2500
P_8	21000	6300	5070 21000 - 19770	1750 [1] 19250 1558 -	2860 [1] 20714 1558 2766	2730 19542 - -	1440 [1] 18102 1558 -	1560 [1] 18100 1558 -	1780 17878 - -	3510 [1] 14368 1558 -	3480 [1] 12446 1558 -	3430 10574 - -	3700 [1] 6874 1558 -	3690 [1] 4742 1558 -	35000	1558	8	12464	$XP_{11}P_8$ =12464 IP_8 =22536	1000
P_{13}	24500	8400	6800 [1] 24500 -3760* 26660	3850 [1] 20650 - -	4450 [1] 16200 2528 -	4620 [1] 14108 - -	3780 [1] 10328 - -	3170 [1] 7158 - -	4190 [1] 24500 - 21532	4090 [1] 20410 - -	4090 [1] 19360 -3240* 6280	3760 [1] 15600 - -	3800 [1] 11800 - -	3400 [1] 8400 - -	50000	4542	12	54504	$XP_{11}P_{13}$ =2528 IP_{13} =54472 $XP_{13}R_{17}$ =7000*	1000
P_6	3500	1750	1030 [1] 720 980	1170 [1] 530 980	1210 [2] 300 1960	1440 [1] 820 980	1060 [1] 740 980	1130 [2] 590 1960	1040 [1] 1510 980	1630 [1] 860 980	1010 [2] 830 1960	1060 [1] 1730 980	1680 [1] 1030 980	1540 [2] 470 1280	15000	980	16	15680		1000

Table 3.4 Ship schedule .

Port	Warehouse	Initial stock	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Surplus P_{10}	21000		1500 0	3000 1500	6600 0	5100 2273	3000 3773	2700 4973	3000 6473	2400 4446	2700 2719	0 1000	0 0	0
Deficit: R_9	14000	4200	2430 [1] 1770 - 1400*	2210 [1] 960 - 1422*	1950 [2] 432 2927 1422*	2020 [1] 2761 - 1422*	1560 [1] 2623 - 1422*	1530 [2] 2515 - 2844*	1320 [1] 4039 - 2844*	1150 [1] 5733 2927 224*	1490 [2] 7394 2927 -	2050 [1] 8271 219 -	1920 [1] 6570 - -	2370 [2] 4200 - -
R_3	7000	2100	610 [1] 1490 -	360 [1] 1130 -	240 [2] 890 3673	180 [1] 4383 1327	280 [1] 5430 -	230 [2] 5200 -	340 [1] 4860 -	380 [1] 4480 -	430 [2] 4050 -	530 [1] 3520 -	680 [1] 2840 -	740 [2] 2100 -
R_4	7000	2100	1360 [1] 740 1500	1710 [1] 530 1500	1480 [1] 550 1500	1230 [1] 820 1500	790 [1] 1530 1500	850 [1] 2180 1500	1010 [1] 2670 1500	780 [1] 3390 1500	1040 [1] 3050 1500	1150 [1] 4200 1500	2320 [1] 3380 1000	2280 [1] 2100 -
Surplus: S_2	3500		500 0	1000 0	2200 0	1700 0	1000 0	900 0	1000 0	800 0	900 0	0 0	0 0	0 0
S_3	3500		500 0	1000 0	2200 0	1700 0	1000 0	900 0	1000 0	800 0	900 0	0 0	0 0	0 0
Deficit: R_{15}	7000	2100	1430 [1] 670 1000	1370 [1] 300 2000	1520 [1] 780 4400	1530 [1] 3650 3400	1580 [1] 5470 2000	1590 [1] 5880 1800	1600 [1] 6030 2000	2010 [1] 6070 1600	1920 [1] 5750 1800	1860 [1] 5690 -	1810 [1] 3880 -	1780 [1] 2100 -
Supplier P_{13}	24500	8400	-6800 24500 - 26660	-3950 20650 -	-4450 16200 2528* -	-4620 14108 - -	-3780 10328 - -	-3170 7158 -	-4190 24500 - 21532	-4090 20410 -	-4090 19360 - 6280	-3760 15600 -	-3800 11800 - -	-3400 8400 - -
Deficit R_{17}	3500	1050	740 [1] 310 3760	570 [1] 3500 -	410 3090 -	360 [1] 2730 -	400 [1] 2330 -	350 1980 -	410 [1] 1570 -	470 [1] 1100 -	670 430 3240	790 [1] 2880 -	850 [1] 2030 -	980 1050 -
Supplier P_4	24500	8400	-7600 16500 25000	-5640 10860	-5370 24500 19010	-5620 10880	-4780 14100	-2920 24500 20360	-5720 107900	-2910 15870	-3510 17340	-3900 5980	-5870 14540 14430	-6140 8400
Deficit R_7	7000	2800	2740 [1] 60 9300 575*	2950 [1] 6985 - 575*	2990 [2] 4570 - 1150*	2900 [1] 2820 - 575*	2080 [1] 1315 - 575*	1400 [2] 490 7040 1150*	1680 [1] 7000 - 575*	2440 [1] 5135 - 575*	2200 [2] 3510 - 1150*	2530 [1] 2130 2460 575*	3080 [1] 2095 - 575*	1010 [2] 1670 - 1150*
Supplier P_2	45500	13650	-7820 40210 37500	-7110 33110	-8940 24160	-8710 15450	-8920 40100 37500	-9230 31170	-7910 23230	-8560 14670	-8260 38290 35000	-8120 30170	-7810 22230	-8580 13650
Deficit R_1	3500	1050	960 [2] 90 3120	970 [3] 2240 -	890 [2] 1350 -	840 [3] 510 3610	640 [2] 3500 -	650 [3] 2850 -	760 [2] 2090 -	810 [3] 1280 -	820 [2] 460 3120	810 [3] 2770 -	890 [2] 1880 130	960 [3] 1050 -
Supplier P_3	10500	3150	-1420 10500 9770	-1440 8560	-1200 6780	-1210 5070	-1070 3550	-910 2640	-910 10500 9270	-910 9090	-1100 7490	-1200 5790	-1300 3990	-1300 3150 460
Deficit R_5	3500	1050	420 [1] 630 500	390 [1] 740 500	310 [1] 910 500	350 [1] 1000 500	210 1370 500	310 [1] 1560	310 [1] 1250 500	280 [1] 1470 500	460 [1] 1510 500	570 [1] 1440 500	390 [1] 1550 500	1000 1050

Port	Total activities	Shipment capacity per trip	Number of trips	Total shipment capacity		Loading & unloading capacity/day
Surplus P_{10}	30000					1500
Deficit: R_9	22000	2927 *1422	16 20	46832 28440	$XP_{10}R_9$=9000 $XP_{11}R_9$=13000	500
R_3	5000	1894	16	30304		500
R_4	16000	1500	12	18000		500
Surplus: S_2	10000					500
S_3	10000					500
Deficit: R_{15}	20000	6864 5336	12 13	82368 69368	XS_2R_{15}=10000 XS_3R_{15}=10000	500
Supplier P_{13}	50000				$XP_{11}R_{13}$=2528*	1500
Deficit R_{17}	7000	5476	8	43808	$XP_{13}R_{17}$=7000 IP_{13}=54472	500
Supplier P_4	78800					1000
Deficit R_7	28000	11078 *575	12 16	132936 9200	XP_4P_7=18800 $XP_{11}R_7$=9200	500
Supplier P_2	110000					1500
Deficit R_1	10000	1560	30	46800		500
Supplier P_3	19000					1000
Deficit R_5	5000	500	10	5000		500

Table 3.5 Ship schedule

Ports	Warehouse capacity	Initial stock	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Total activities	Shipment capacity per trip	Number of trips	Total shipment capacity	Loading & unloading capacity/day
Supplier: P_{14}	28000	8400	-3560 28000 23160	-4620 21043 —	-3460 17583 —	-4430 13153 —	-3730 9423 —	-2740 27009 25000	-3670 23339 —	-3940 19399 —	-3530 12880 —	-3420 9460 —	-3740 5720 —	-4160 8400 6840	55000				1000
Deficit R_{13}	10500	3150	1100 (1) 2050 -	1040 (1) 1010 2337	1010 (2) 2337 -	760 (1) 1577 -	690 (1) 887 -	650 (2) 237 4674	630 (1) 4281 -	640 (1) 3641 -	640 (2) 3001 2989	610 (1) 5380 -	1210 (1) 4170 -	1020 (2) 3150 -	10000	2337	16	37392	500
Supplier P_{15}	19500	5850	-1020 19500 18870	-2620 16880 -	11320 15560 -	-1570 13990 -	-2020 7770 -	-1770 6000 -	-2600 3400 -	-1720 1680 -	-1260 10350 14130	-1480 8870 -	-1650 6820 -	-970 5850 -	33000				1000
Deficit R_{18}	7000	2100	1180 (1) 920 4200	1060 (1) 4060 -	1050 (1) 3010 -	1140 (1) 1870 -	1010 (1) 860 4200	1080 3980 -	980 (1) 3000 -	1060 (1) 1940 -	1080 (1) 860 420	1180 (1) 3880 -	1180 (1) 2700 400	1000 2100 -	13000	4200	10	42000	500
Imports P_2	7000	3500	3250 7000 6750	2030 4970 —	1970 3000 —	1970 7000 5970	1480 5520 —	1510 4010 —	1720 2290 —	1620 7000 6330	1710 5290 —	2690 7000 4400	3700 7000 3700	4350 3500 850	28000				1000
P_5	3500	2500	2320 3500 3320	2500 3500 2500	2750 3500 2750	3120 3500 3120	2420 3500 2420	2920 3500 2920	2710 3500 2710	2430 3500 2430	2490 3500 2490	1790 3500 1790	2080 3500 2080	2470 3500 1470	30000				1000
P_9	14000	4200	3810 14000 13610	3880 10120 —	2440 7680 —	3630 4050 —	2420 14000 12370	1170 12830 —	2180 10650 —	1540 9110 —	3170 5940 —	2410 3530 —	2070 5480 4020	1280 4200 —	30000				1000
P_{12}	10500	3150	1500 10500 8850	1090 9410 —	1370 8040 —	1460 6580 —	1340 5240 —	1050 4190 —	1170 3020 —	990 2030 —	930 1100 —	970 6280 6150	1540 4740 —	1590 3150 —	15000				1000

Table 3.6. Domestic scheduling (in metric tons).

Route	Month											
	A	M	J	J	A	S	O	N	D	J	F	M
(P_{11},R_2)	-	-	-	-	-	2000	-	-	-	-	-	-
(P_{11},R_6)	1200	2274	-	4226	-	-	-	3600	700	-	-	-
(P_{11},R_7)	575	575	1150	575	575	1150	575	575	1150	575	575	1150
(P_{11},R_8)	220	2345	2345	2345	2345	1330	-	-	2345	1725	-	-
(P_{11},R_9)	1400	1422	1422	1422	1422	2844	2844	224	-	-	-	-
(P_{11},R_{10})	425	300	2484	-	-	-	2791	-	-	-	-	-
(P_{11},R_{11})	-	300	5600	-	-	5600	-	-	-	-	3500	-
(P_{11},R_{12})	1000	1000	4220	-	-	-	-	-	3780	-	-	-
(P_{11},R_{14})	1000	730	2337	2337	-	-	-	-	2596	-	-	-
(P_{11},R_{16})	1000	760	4300	-	-	-	-	3940	-	-	-	-
(P_{11},R_{19})	2200	2280	8620	-	-	7090	-	-	-	4810	-	-
(P_{11},P_7)	-	5476	5476	-	5476	5476	-	5476	5476	-	5476	5476
(P_{11},P_8)	-	1558	1558	-	1558	1558	-	1558	1558	-	1558	1558
(P_{11},P_{13})	-	-	2528	-	-	-	-	-	-	-	-	-
(P_{11},P_6)	980	980	1960	980	980	1960	980	980	1960	980	980	1280
(P_{10},P_9)	-	-	2927	-	-	-	-	2927	2927	219	-	-
(P_{10},R_3)	-	-	3673	1327	-	-	-	-	-	-	-	-
(P_{10},R_4)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1000	1500
(S_2,R_{15})	500	1000	2200	1700	1000	900	1000	800	900	-	-	-
(S_3,R_{15})	500	1000	2200	1700	1000	900	1000	800	900	-	-	-
(P_{13},R_{17})	3760	-	-	-	-	-	-	-	3240	-	-	-
(P_4,R_7)	9300	-	-	-	-	7040	-	-	-	2460	-	-
(P_1,R_1)	3120	-	-	3630	-	-	-	-	3120	-	130	-
(P_3,R_5)	500	500	500	500	500	-	500	500	500	500	500	-
(P_{14},R_{13})	-	2337	-	-	-	4674	-	-	2989	-	-	-
(P_{15},R_{18})	4200	-	-	-	4200	-	-	-	4200	-	400	-

Table 3.7 Import scheduling (in metric tons)

Ports	Month											
	A	M	J	J	A	S	O	N	D	J	F	M
P_1	37500	-	-	37500	-	-	-	-	35000	-	-	-
P_2	6750	-	-	5970	-	-	-	6330	-	4400	3700	850
P_3	9270	-	-	-	-	-	9270	-	-	-	-	460
P_4	25000	-	19010	-	-	20360	-	-	-	-	14430	-
P_5	3320	2500	2750	3120	2420	2920	2710	2430	2490	1790	2080	1470
P_7	-	50000	-	50000	-	50000	-	50000	-	56162	-	-
P_8	19770	-	2766	-	-	-	-	-	-	-	-	-
P_9	13610	-	-	-	12370	-	-	-	-	-	4020	-
P_{12}	8850	-	-	-	-	-	-	-	-	6150	-	-
P_{13}	26660	-	-	-	-	-	21532	-	6280	-	-	-
P_{14}	23160	-	-	-	-	25000	-	-	-	-	-	6840
P_{15}	18870	-	-	-	-	-	-	-	14130	-	-	-

CHAPTER 4

SENSITIVITY ANALYSIS

The sensitivity or range analysis extends the information provided in the conventional solution. It has the effect of making more useful the interpretation of the shadow prices by providing an estimate of the range over which a shadow price is relevant.

The range output can be obtained with ease with MPS/360 routine. A RANGE card is added in the control deck immediately following the SOLUTION card. No additional data cards or instructions are required of the user.

Interpretation of the range reports in Appendix I and II contain four sections as follows:

1. Section 1, Rows at Limit Level, reports on the restraint rows where the slack activity is at zero level. Thus demand restraints presented in this section are fully supplied and resource restraints are fully used in this allocation planning.
2. Section 2, Columns at Limit Level, is concerned in the rice allocation planning context with those activities which have been left out of the plan. They are at a lower limit of zero.
3. Section 3, Rows and Intermediate Level, provides an analysis of restraints with slack activities at non zero level.
4. Section 4, Columns at Intermediate Level, analyzes the activities which are in the basis.

The range analysis of the solution in Appendix I (see range section) is shown in four sections and discussed section by section.

Section 1. Rows at Limit Level

The columns of particular interest in this section are 5,6, and 7. The first four appear in the previous output and hence need no further explanation. Column 6, labeled unit cost, shows the shadow price or marginal value of each activity. Column 5 (lower activity; upper activity) shows the range of the activity over which the corresponding shadow price is relevant. For example, the shadow price of the stockpile at surplus port P_{10} (activity number 30; row MBP_{10}) is Rp 1032. Each metric ton added beyond 30,000 to 35,000 would reduce the solution by Rp 1032 per metric ton.

Column 7 specifies the activities now in the basis that drop out at the lower and upper limits of the constant marginal value of the surplus. In this case the activity IP_8, which is the amount of imported rice at P_8, drops out if the value of surplus at P_{10} is increased above 35,000.

Section 2. Columns at Limit Level.

In this section we are dealing with real activities included in the model which did not enter the plan. They are at their lower limit of zero. Column 4 gives the penalty cost for each activity, this column repeats the shadow price information for the nonbasic real activities that is supplied in the previous output report. Looking first at activity XP_7R_1 (activity number 42) we observe that the penalty cost (reported in column 4 of Section 2 as Unit Cost) is Rp 2088. Column 3 indicates that this cost penalty is constant over a range of - 300,000 to 10,000 metric tons. Since a real activity carried on at a negative level is impossible, the real range of the constant cost penalty is from 0 (the present level) to 10,000 metric tons of activity. If we forced XP_7R_1 into the plan beyond the 10,000 level, the cost penalty would increase, but the range report supplies no information concerning the magnitude of the increase. We would have to rerun the problem to determine this information. Column 5 indicates that activity XP_7R_1 would enter the plan at a level of 10,000 metric tons if the shipping costs per unit is reduced from Rp 4344 to Rp 2256.

Section 3. Rows at Intermediate Level.

This section provides an analysis of restraints with slack activities at non zero level. The range report supplies no activities at non zero level.

Section 4. Columns at Intermediate Level.

This section reports on the activities which are part of the shipping plan. Because the plan is optimum, deviating from it will cause a decrease in the value of the program. We can deviate from the plan, in respect to any activity, by including the activity at a level either higher or lower than specified in the optimum plan. The range analysis of the activities in the plan provides insight into the magnitude of the cost penalties which are attached to departing from the optimum on either the up or the down side. Activity $XP_{11}R_{11}$ (activity number 122) is the solution at a level of 7000 metric tons. The first row of column 5 indicates that a cost penalty of 88 arises for each unit metric ton, the activity is decreased below the optimum. The same penalty applies until the activity is decreased to 2000. Below this the penalty presumably increases. If $XP_{11}R_{11}$ is pushed beyond the optimum, the penalty is Rp 22 per metric ton. The same penalty applies up to 14000 metric tons.

Column 6 provides an estimate of the sensitivity of $XP_{11}R_{11}$ to changes in the objective function coefficient. $XP_{11}R_{11}$ has an objective function coefficient of Rp 3328 (input cost). This coefficient can vary from Rp 3306 to Rp 3416 before changes in the level of $XP_{11}R_{11}$ in the solution would occur.

The above discussion dealt with the optimal solution. This optimal analysis is important for several reasons:

a) Data uncertainty.

The information that is used in formulating the linear program may be uncertain. Further rice surplus, demand, imports and cost data are usually determined through projection and average patterns, which are far from being known with complete accuracy.

b) Dynamic considerations.

Even if the data were known with complete certainty, we would still want to perform a sensitivity analysis on the optimal solution to find out how the recommended courses of action should be modified after some time, when changes most probably would have taken place in the original specifications of the problem.

CHAPTER 5

CONCLUDING REMARKS

The purpose of this study was to develop an efficient distribution model which reflects the problems of distributing rice.

This problem has not been solved previously. The above approach is a first attempt to do so. The development of the distribution model with the appropriate constraints and the iterative approach for finding workable solutions is new.

The heart of the planning system consists of using the LP models. The results obtained in this study show that linear programming is a successful analytical method for solving the distribution planning problem. Upper and lower bounds on particular variables can be incorporated easily into the model. The IBM MPS/360 computer programing package is a good program for solving these types of problems.

The distribution planning model can be used to analyze many aspects of the problem. The general method is to rerun the model with different values of coefficients and constraints. As problems occur during the year the model is useful in determining the effect of unexpected occurrences of unusual weather conditions, plant diseases and ship shortages. Policies can be established in anticipation of these problems. For example, if the crop failed in a certain region, the corrective policies can be determined by rerunning the model with the adjusted values and determine the amount of imported rice needed.

Having the distribution planning procedure firmly established it enables one to make cargo trades with shipping companies to transport certain tonnages of grain between any supply port and destination port. The net effect of such a trade on any one company is to reduce the total shipping cost. The effect of entering into a contract for a new tonnage, or of losing such a contract due to the changes in demand, can be easily determined by setting the new values and rerunning the model.

An essential ingredient for the success of such a study as this, is the availability and accuracy of demand, domestic procurement and cost data. Currently, the biggest problem that has to be overcome is that the traditional record keeping does not provide the detailed information required. A comparison between the proposed transportation scheme with the actual distribution system cannot be made because of the lack of data. Even if the savings were minimal the proposed method minimize the manpower effort required to obtain a workable shipping schedule. Because of the limitations of data, this study emphasizes a methodology rather than that of obtaining exact solutions.

Currently the government is faced with the uncertain international market for rice and other commodities as well as domestic procurement. It is well documented that in 1972 there was a rice shortage in the domestic market as well as in the international commercial market. When a rice shortage occurs more complex distribution problems are created. Goals such as the general economic health and social responsibilities are given higher priorities than cost minimization. Consumer preferences are also considered to play a significant role. For example, most consumers in the eastern part of the country prefer domestic rice to imported rice. Consumers in the capital city, which is heavily populated, prefer imported rice to domestic rice. If the supplies do not meet these preferences the existing rice trade system may be disturbed. These conditions create instability of the price of rice in the domestic trade system. As a consequence decisions are weighted by consumer preferences. Inventory costs must also be considered, e.g investment in rice, warehouse costs etc. It is therefore desireable to use up the domestic supply in each period (month).

The sensitivity analysis (Range analysis) of the solutions are presented in Appendix I and II. The analysis yields a shadow price for each variable and range on the coefficients of the objective function (shipping costs). These shadow prices and ranges on shipping costs give a sensitivity measure to each route, which is useful in suggesting alternates to the optimal solutions. Significant insight into the distribution operation can thus be obtained.

As an extension of this overall planning model, the optimum intra-regional distribution pattern can be determined by sub-models, using the solution of the regional model as constraints to the sub-models. The sub-models optimize within regions in the same manner as the overall model optimizes among them.

In truth, the rice distribution planning should not be focused upon the optimization of a single objective criterion, namely the minimization of total transportation costs. There is a need to consider additional objectives. The study of such methods are called multiple objective decision making. They will not be treated in this paper but are recommended for future work.

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Appendix I.

The basic distribution network solutions

```
0001                PROGRAM
0002                INITIALZ
0065                MOVE(XDATA,'EXAMPLE')
0066                MOVE(XPBNAME,'PBFILE')
0067                CONVERT('SUMMARY')
0068                BCDOUT
0069                SETUP('MIN')
0070                MOVE(XOBJ,'COST')
0071                MOVE(XRHS,'RHS1')
0072                PICTURE
0073                PRIMAL
0074                SOLUTION
0075                RANGE
0076                EXIT
0077                PEND
```

```
CONVERT EXAMPLE  TO PBFILE
TIME =   0.01
    SUMMARY

1- ROWS SECTION.

   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
2- COLUMNS SECTION.

   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
3- RHS'S SECTION.
  RHS1
   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
```

SOLUTICN (OPTIMAL)

TIME = 0.10 MINS. ITERATICN NUMBER = 56

...NAME...	...ACTIVITY...	DEFINED AS
FUNCTIONAL	3136734000.00	COST
RESTRAINTS		RHS1

SECTION 1 - ROWS

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT.	..UPPER LIMIT.	.DUAL ACTIVITY
1	COST	BS	3136734000.00	3136734000.00-	NONE	NONE	1.00000
2	MBR1	EQ	10000.00000	.	10000.00000	10000.00000	4504.00000-
3	MBR2	EQ	2000.00000	.	2000.00000	2000.00000	3336.00000-
4	MBR3	EQ	5000.00000	.	5000.00000	5000.00000	3736.00000-
5	MBR4	EQ	16000.00000	.	16000.00000	16000.00000	3576.00000-
6	MBR5	EQ	5000.00000	.	5000.00000	5000.00000	2928.00000-
7	MBR6	EQ	12000.00000	.	12000.00000	12000.00000	3632.00000-
8	MBR7	EQ	28000.00000	.	28000.00000	28000.00000	3696.00000-
9	MBR8	EQ	15000.00000	.	15000.00000	15000.00000	3248.00000-
10	MBR9	EQ	22000.00000	.	22000.00000	22000.00000	2280.00000-
11	MBR10	EQ	6000.00000	.	6000.00000	6000.00000	3936.00000-
12	MBR11	EQ	15000.00000	.	15000.00000	15000.00000	3328.00000-
13	MBR12	EQ	10000.00000	.	10000.00000	10000.00000	3368.00000-
14	MBR13	EQ	10000.00000	.	10000.00000	10000.00000	4552.00000-
15	MBR14	EQ	9000.00000	.	9000.00000	9000.00000	3752.00000-
16	MBR15	EQ	20000.00000	.	20000.00000	20000.00000	3536.00000-
17	MBR16	EQ	10000.00000	.	10000.00000	10000.00000	4440.00000-
18	MBR17	EQ	7000.00000	.	7000.00000	7000.00000	4906.00000-
19	MBR18	EQ	13000.00000	.	13000.00000	13000.00000	5816.00000-
20	MBR19	EQ	25000.00000	.	25000.00000	25000.00000	6208.00000-
21	MBP1	EQ	100000.00000	.	100000.00000	100000.00000	2248.00000-
22	MBP2	EQ	28000.00000	.	28000.00000	28000.00000	2248.00000-
23	MBP3	EQ	14000.00000	.	14000.00000	14000.00000	2248.00000-
24	MBP4	EQ	60000.00000	.	60000.00000	60000.00000	2248.00000-
25	MBP5	EQ	30000.00000	.	30000.00000	30000.00000	2248.00000-
26	MBP6	EQ	15000.00000	.	15000.00000	15000.00000	2248.00000-
27	MBP7	EQ	300000.00000	.	300000.00000	300000.00000	2248.00000-
28	MBP8	EQ	35000.00000	.	35000.00000	35000.00000	2248.00000-
29	MBP9	EQ	30000.00000	.	30000.00000	30000.00000	2248.00000-
30	MBP10	UL	30000.00000	.	NONE	30000.00000	1032.00000
31	MBP11	BS	200000.00000	.	NONE	200000.00000	.
32	MBP12	EQ	15000.00000	.	15000.00000	15000.00000	2248.00000-
33	MBP13	EQ	50000.00000	.	50000.00000	50000.00000	2248.00000-
34	MBP14	EQ	45000.00000	.	45000.00000	45000.00000	2248.00000-
35	MBP15	EQ	20000.00000	.	20000.00000	20000.00000	2248.00000-
36	MBS2	UL	10000.00000	.	NONE	10000.00000	56.00000
37	MBS3	UL	10000.00000	.	NONE	10000.00000	520.00000
38	TOTDEM	EQ	732000.00000	.	732000.00000	732000.00000	752.00000-

SECTION 2 - COLUMNS

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
39	XP1R1	BS	10000.00000	2256.00000	.	NONE	.
40	XP2R1	LL	.	3528.00000	.	NONE	1272.00000
41	XP3R1	LL	.	4500.00000	.	NONE	2244.00000
42	XP7R1	LL	.	4344.00000	.	NONE	2088.00000
43	XP10R1	LL	.	4648.00000	.	NONE	1176.00000
44	XP11R1	LL	.	4920.00000	.	NONE	416.00000
45	XP1R2	LL	.	2320.00000	.	NONE	1232.00000
46	XP3R2	BS	2000.00000	1088.00000	.	NONE	.
47	XP4R2	LL	.	2480.00000	.	NONE	1392.00000
48	XP5R2	LL	.	3000.00000	.	NONE	1912.00000
49	XP6R2	LL	.	3500.00000	.	NONE	2412.00000
50	XP7R2	LL	.	3608.00000	.	NONE	2520.00000
51	XP10R2	LL	.	3912.00000	.	NONE	1608.00000
52	XP11R2	LL	.	4192.00000	.	NONE	856.00000
53	XP1R3	LL	.	2880.00000	.	NONE	1392.00000
54	XP3R3	BS	5000.00000	1488.00000	.	NONE	.
55	XP4R3	LL	.	3272.00000	.	NONE	1784.00000
56	XP5R3	LL	.	6500.00000	.	NONE	5012.00000
57	XP6R3	LL	.	6750.00000	.	NONE	5262.00000
58	XP7R3	LL	.	3696.00000	.	NONE	2208.00000
59	XP10R3	LL	.	4016.00000	.	NONE	1312.00000
60	XP11R3	LL	.	4560.00000	.	NONE	824.00000
61	XP1R4	LL	.	2944.00000	.	NONE	1616.00000
62	XP3R4	LL	.	2048.00000	.	NONE	720.00000
63	XP4R4	LL	.	2224.00000	.	NONE	896.00000
64	XP5R4	LL	.	2008.00000	.	NONE	680.00000
65	XP6R4	LL	.	2528.00000	.	NONE	1200.00000
66	XP7R4	LL	.	3112.00000	.	NONE	1784.00000
67	XP10R4	LL	.	3408.00000	.	NONE	864.00000
68	XP11R4	BS	16000.00000	3576.00000	.	NONE	.
69	XP1R5	LL	.	2336.00000	.	NONE	1656.00000
70	XP3R5	BS	5000.00000	680.00000	.	NONE	.
71	XP4R5	LL	.	2944.00000	.	NONE	2264.00000
72	XP5R5	LL	.	6000.00000	.	NONE	5320.00000
73	XP6R5	LL	.	6250.00000	.	NONE	5570.00000
74	XP7R5	LL	.	3416.00000	.	NONE	2736.00000
75	XP10R5	LL	.	3720.00000	.	NONE	1824.00000
76	XP11R5	LL	.	3944.00000	.	NONE	1016.00000
77	XP2R6	LL	.	1992.00000	.	NONE	608.00000
78	XP4R6	LL	.	3368.00000	.	NONE	1984.00000
79	XP5R6	LL	.	2200.00000	.	NONE	816.00000
80	XP6R6	LL	.	2776.00000	.	NONE	1392.00000
81	XP7R6	LL	.	2824.00000	.	NONE	1440.00000
82	XP10R6	LL	.	3312.00000	.	NONE	712.00000
83	XP11R6	BS	12000.00000	3632.00000	.	NONE	.
84	XP1R7	LL	.	4224.00000	.	NONE	2776.00000
85	XP3R7	LL	.	4500.00000	.	NONE	3052.00000
86	XP4R7	LL	.	2288.00000	.	NONE	840.00000
87	XP5R7	LL	.	2376.00000	.	NONE	928.00000

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
88	XP6R7	LL	.	2776.00000	.	NONE	1328.00000
89	XP7R7	LL	.	3232.00000	.	NONE	1784.00000
90	XP10R7	LL	.	3536.00000	.	NONE	872.00000
91	XP11R7	BS	28000.00000	3696.00000	.	NONE	.
92	XP2R8	LL	.	3216.00000	.	NONE	2216.00000
93	XP4R8	LL	.	3040.00000	.	NONE	2040.00000
94	XP5R8	LL	.	6100.00000	.	NONE	5100.00000
95	XP6R8	LL	.	6300.00000	.	NONE	5300.00000
96	XP7R8	LL	.	1304.00000	.	NONE	304.00000
97	XP10R8	LL	.	2656.00000	.	NONE	440.00000
98	XP11R8	BS	15000.00000	3248.00000	.	NONE	.
99	XP7R9	LL	.	3264.00000	.	NONE	3232.00000
100	XP8R9	LL	.	2960.00000	.	NONE	2928.00000
101	XP9R9	LL	.	3400.00000	.	NONE	3368.00000
102	XP10R9	LL	.	2688.00000	.	NONE	1440.00000
103	XP11R9	BS	22000.00000	2280.00000	.	NONE	.
104	XP12R9	LL	.	2624.00000	.	NONE	2592.00000
105	XP13R9	LL	.	2840.00000	.	NONE	2808.00000
106	XS2R9	LL	.	4750.00000	.	NONE	2526.00000
107	XS3R9	LL	.	5000.00000	.	NONE	3240.00000
108	XP7R10	LL	.	4552.00000	.	NONE	2864.00000
109	XP8R10	LL	.	5000.00000	.	NONE	3312.00000
110	XP9R10	LL	.	5000.00000	.	NONE	3312.00000
111	XP10R10	LL	.	4368.00000	.	NONE	1464.00000
112	XP11R10	BS	6000.00000	3936.00000	.	NONE	.
113	XP12R10	LL	.	2888.00000	.	NONE	1200.00000
114	XP13R10	LL	.	3408.00000	.	NONE	1720.00000
115	XP14R10	LL	.	3784.00000	.	NONE	2096.00000
116	XS2R10	LL	.	5000.00000	.	NONE	1120.00000
117	XS3R10	LL	.	5000.00000	.	NONE	1584.00000
118	XP7R11	LL	.	4080.00000	.	NONE	3000.00000
119	XP8R11	LL	.	3600.00000	.	NONE	2520.00000
120	XP9R11	LL	.	3928.00000	.	NONE	2848.00000
121	XP10R11	LL	.	3536.00000	.	NONE	1240.00000
122	XP11R11	BS	7000.00000	3328.00000	.	NONE	.
123	XP12R11	BS	8000.00000	1080.00000	.	NONE	.
124	XP13R11	LL	.	2632.00000	.	NONE	1552.00000
125	XP14R11	LL	.	3544.00000	.	NONE	2464.00000
126	XS2R11	LL	.	5000.00000	.	NONE	1728.00000
127	XS3R11	LL	.	5250.00000	.	NONE	2442.00000
128	XP7R12	LL	.	3984.00000	.	NONE	2864.00000
129	XP8R12	LL	.	6000.00000	.	NONE	4880.00000
130	XP10R12	LL	.	3584.00000	.	NONE	1248.00000
131	XP11R12	BS	10000.00000	3368.00000	.	NONE	.
132	XP12R12	LL	.	1800.00000	.	NONE	680.00000
133	XP13R12	LL	.	2600.00000	.	NONE	1480.00000
134	XP14R12	LL	.	3064.00000	.	NONE	1944.00000
135	XS2R12	LL	.	4600.00000	.	NONE	1288.00000
136	XS3R12	LL	.	3120.00000	.	NONE	272.00000
137	XP7R13	LL	.	5360.00000	.	NONE	3056.00000
138	XP8R13	LL	.	7500.00000	.	NONE	5196.00000

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
139	XP10R13	LL	.	7250.00000	.	NONE	3730.00000
140	XP11R13	BS	10000.00000	4552.00000	.	NONE	.
141	XP12R13	LL	.	7500.00000	.	NONE	5196.00000
142	XP13R13	LL	.	4500.00000	.	NONE	2196.00000
143	XP14R13	LL	.	2624.00000	.	NONE	320.00000
144	XS2R13	LL	.	7000.00000	.	NONE	2504.00000
145	XS3R13	LL	.	7100.00000	.	NONE	3068.00000
146	XP7R14	LL	.	4456.00000	.	NONE	2952.00000
147	XP8R14	LL	.	6200.00000	.	NONE	4696.00000
148	XP10R14	LL	.	6100.00000	.	NONE	3380.00000
149	XP11R14	BS	9000.00000	3752.00000	.	NONE	.
150	XP12R14	LL	.	6000.00000	.	NONE	4496.00000
151	XP13R14	LL	.	2736.00000	.	NONE	1232.00000
152	XP14R14	LL	.	5000.00000	.	NONE	3496.00000
153	XP15R14	LL	.	5500.00000	.	NONE	3996.00000
154	XS2R14	LL	.	5750.00000	.	NONE	2054.00000
155	XS3R14	LL	.	5500.00000	.	NONE	2268.00000
156	XP7R15	LL	.	4320.00000	.	NONE	3032.00000
157	XP11R15	BS	10000.00000	3536.00000	.	NONE	.
158	XP13R15	LL	.	3112.00000	.	NONE	1824.00000
159	XS2R15	LL	.	4500.00000	.	NONE	1020.00000
160	XS3R15	BS	10000.00000	3016.00000	.	NONE	.
161	XP7R16	LL	.	5136.00000	.	NONE	2944.00000
162	XP11R16	BS	10000.00000	4440.00000	.	NONE	.
163	XP13R16	LL	.	3640.00000	.	NONE	1448.00000
164	XP14R16	LL	.	2248.00000	.	NONE	56.00000
165	XP15R16	LL	.	2576.00000	.	NONE	384.00000
166	XP7R17	LL	.	5528.00000	.	NONE	2870.00000
167	XP11R17	BS	7000.00000	4906.00000	.	NONE	.
168	XP12R17	LL	.	8000.00000	.	NONE	5342.00000
169	XP13R17	LL	.	3984.00000	.	NONE	1326.00000
170	XP14R17	LL	.	3112.00000	.	NONE	454.00000
171	XP15R17	LL	.	2680.00000	.	NONE	22.00000
172	XP7R18	LL	.	15000.00000	.	NONE	11432.00000
173	XP11R18	BS	13000.00000	5816.00000	.	NONE	.
174	XP13R18	LL	.	4632.00000	.	NONE	1064.00000
175	XP14R18	LL	.	10000.00000	.	NONE	6432.00000
176	XP15R18	LL	.	3680.00000	.	NONE	112.00000
177	XP7R19	LL	.	6672.00000	.	NONE	2712.00000
178	XP11R19	BS	25000.00000	6208.00000	.	NONE	.
179	XP13R19	LL	.	5248.00000	.	NONE	1288.00000
180	XP14R19	LL	.	10500.00000	.	NONE	6540.00000
181	XP15R19	LL	.	4179.00000	.	NONE	219.00000
182	XP10P3	LL	.	3880.00000	.	NONE	2664.00000
183	XP10P4	LL	.	3216.00000	.	NONE	2000.00000
184	XP10P5	LL	.	2928.00000	.	NONE	1712.00000
185	XP10P6	LL	.	2632.00000	.	NONE	1416.00000
186	XP10P7	LL	.	2096.00000	.	NONE	880.00000
187	XP10P8	BS	30000.00000	1216.00000	.	NONE	.
188	XP10P9	LL	.	3160.00000	.	NONE	1944.00000
189	XP11P1	LL	.	4552.00000	.	NONE	2304.00000

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
190	XP11P2	LL	.	4152.00000	.	NONE	1904.00000
191	XP11P3	LL	.	4120.00000	.	NONE	1872.00000
192	XP11P4	LL	.	3536.00000	.	NONE	1288.00000
193	XP11P5	LL	.	3624.00000	.	NONE	1376.00000
194	XP11P6	LL	.	3072.00000	.	NONE	824.00000
195	XP11P7	LL	.	2912.00000	.	NONE	664.00000
196	XP11P8	LL	.	2336.00000	.	NONE	88.00000
197	XP11P9	LL	.	3344.00000	.	NONE	1096.00000
198	XP11P12	LL	.	3216.00000	.	NONE	968.00000
199	XS2P12	LL	.	5552.00000	.	NONE	3360.00000
200	XS3P12	LL	.	3016.00000	.	NONE	1288.00000
201	XP11P13	LL	.	3160.00000	.	NONE	912.00000
202	XS2P13	BS	10000.00000	2192.00000	.	NONE	.
203	XS3P13	LL	.	2432.00000	.	NONE	704.00000
204	XP11P14	LL	.	4672.00000	.	NONE	2424.00000
205	XP11P15	LL	.	6208.00000	.	NONE	3960.00000
206	IP1	BS	110000.00000	3000.00000	.	NONE	.
207	IP2	BS	28000.00000	3000.00000	.	NONE	.
208	IP3	BS	26000.00000	3000.00000	.	NONE	.
209	IP4	BS	60000.00000	3000.00000	.	NONE	.
210	IP5	BS	30000.00000	3000.00000	.	NONE	.
211	IP6	BS	15000.00000	3000.00000	.	NONE	.
212	IP7	BS	300000.00000	3000.00000	.	NONE	.
213	IP8	BS	5000.00000	3000.00000	.	NONE	.
214	IP9	BS	30000.00000	3000.00000	.	NONE	.
215	IP10	LL	.	3000.00000	.	NONE	1216.00000
216	IP11	LL	.	3000.00000	.	NONE	2248.00000
217	IP12	BS	23000.00000	3000.00000	.	NONE	.
218	IP13	BS	40000.00000	3000.00000	.	NONE	.
219	IP14	BS	45000.00000	3000.00000	.	NONE	.
220	IP15	BS	20000.00000	3000.00000	.	NONE	.

RANGE

TIME = 0.13 MINS. ITERATION NUMBER = 56

...NAME...	...ACTIVITY...	DEFINED AS
FUNCTIONAL	3136733952.00	COST
RESTRAINTS		RHS1

SECTION 1 - ROWS AT LIMIT LEVEL

	Column 1		Column 2	Column 3	Column 4	Column 5	Column 6		Column 7	
NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
2	MBR1	EQ	10000.00000	.	10000.00000 10000.00000	3000.00000 10000.00000	4503.99609- 4503.99609		XP11R11 MBP11	LL UL
3	MBR2	EQ	2000.00000	.	2000.00000 2000.00000	. 2000.00000	3335.99976- 3335.99976		XP3R2 MBP11	LL UL
4	MBR3	EQ	5000.00000	.	5000.00000 5000.00000	. 5000.00000	3735.99976- 3735.99976		XP3R3 MBP11	LL UL
5	MBR4	EQ	16000.00000	.	16000.00000 16000.00000	. 16000.00000	3576.00000- 3576.00000		XP11R4 MBP11	LL UL
6	MBR5	EQ	5000.00000	.	5000.00000 5000.00000	. 5000.00000	2927.99976- 2927.99976		XP3R5 MBP11	LL UL
7	MBR6	EQ	12000.00000	.	12000.00000 12000.00000	. 12000.00000	3632.00000- 3632.00000		XP11R6 MBP11	LL UL
8	MBR7	EQ	28000.00000	.	28000.00000 28000.00000	. 28000.00000	3696.00000- 3696.00000		XP11R7 MBP11	LL UL
9	MBR8	EQ	15000.00000	.	15000.00000 15000.00000	. 15000.00000	3248.00000- 3248.00000		XP11R8 MBP11	LL UL
10	MBR9	EQ	22000.00000	.	22000.00000 22000.00000	. 22000.00000	2280.00000- 2280.00000		XP11R9 MBP11	LL UL
11	MBR10	EQ	6000.00000	.	6000.00000 6000.00000	. 6000.00000	3936.00000- 3936.00000		XP11R10 MBP11	LL UL
12	MBR11	EQ	15000.00000	.	15000.00000 15000.00000	8000.00000 15000.00000	3327.99976- 3327.99976		XP11R11 MBP11	LL UL
13	MBR12	EQ	10000.00000	.	10000.00000 10000.00000	. 10000.00000	3368.00000- 3368.00000		XP11R12 MBP11	LL UL
14	MBR13	EQ	10000.00000	.	10000.00000 10000.00000	. 10000.00000	4552.00000- 4552.00000		XP11R13 MBP11	LL UL
15	MBR14	EQ	9000.00000	.	9000.00000 9000.00000	. 9000.00000	3752.00000- 3752.00000		XP11R14 MBP11	LL UL
16	MBR15	EQ	20000.00000	.	20000.00000 20000.00000	10000.00391 20000.00000	3535.99976- 3535.99976		XP11R15 MBP11	LL UL
17	MBR16	EQ	10000.00000	.	10000.00000 10000.00000	. 10000.00000	4440.00000- 4440.00000		XP11R16 MBP11	LL UL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
18	MBR17	EQ	7000.00000	.	7000.00000 7000.00000	. 7000.00000	4906.00000- 4906.00000		XP11R17 MBP11	LL UL
19	MBR18	EQ	13000.00000	.	13000.00000 13000.00000	. 13000.00000	5816.00000- 5816.00000		XP11R18 MBP11	LL UL
20	MBR19	EQ	25000.00000	.	25000.00000 25000.00000	. 25000.00000	6208.00000- 6208.00000		XP11R19 MBP11	LL UL
21	MBP1	EQ	100000.00000	.	100000.00000 100000.00000	93000.00000 100000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
22	MBP2	EQ	28000.00000	.	28000.00000 28000.00000	21000.00000 28000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
23	MBP3	EQ	14000.00000	.	14000.00000 14000.00000	7000.00000 14000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
24	MBP4	EQ	60000.00000	.	60000.00000 60000.00000	53000.00000 60000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
25	MBP5	EQ	30000.00000	.	30000.00000 30000.00000	23000.00000 30000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
26	MBP6	EQ	15000.00000	.	15000.00000 15000.00000	8000.00000 15000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
27	MBP7	EQ	300000.00000	.	300000.00000 300000.00000	293000.00000 300000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
28	MBP8	EQ	35000.00000	.	35000.00000 35000.00000	30000.00391 35000.00000	2247.99976- 2247.99976		IP8 MBP11	LL UL
29	MBP9	EQ	30000.00000	.	30000.00000 30000.00000	23000.00000 30000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
30	MBP10	UL	30000.00000	.	NONE 30000.00000	30000.00000 34999.99609	1031.99976 1031.99976-		MBP11 IP8	UL LL
32	MBP12	EQ	15000.00000	.	15000.00000 15000.00000	8000.00000 15000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
33	MBP13	EQ	50000.00000	.	50000.00000 50000.00000	43000.00000 50000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
34	MBP14	EQ	45000.00000	.	45000.00000 45000.00000	38000.00000 45000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL
35	MBP15	EQ	20000.00000	.	20000.00000 20000.00000	13000.00000 20000.00000	2247.99976- 2247.99976		XP11R11 MBP11	LL UL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
36	MBS2	UL	10000.00000	.	NCNE 10000.00000	10000.00000 17000.00000	55.99998 55.99998-		MBP11 XP11R11	UL LL
37	MBS3	UL	10000.00000	.	NCNE 10000.00000	10000.00000 19999.99609	519.99976 519.99976-		MBP11 XP11R15	UL LL
38	TOTDEM	EQ	732000.00000	.	732000.00000 732000.00000	732000.00000 735000.00000	752.00000- 752.00000		MBP11 XP11R11	UL LL

SECTION 2 - COLUMNS AT LIMIT LEVEL

NUMBER	Column 1 .COLUMN.	AT	...ACTIVITY...	Column 2 ..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	Column 3 LOWER ACTIVITY UPPER ACTIVITY	Column 4 ...UNIT COST.. ...UNIT COST..	Column 5 ..UPPER COST.. ..LOWER COST..	Column 6 LIMITING PROCESS.	AT AT
40	XP2R1	LL	.	3528.00000	. NONE	27999.99609- 9999.99609	1272.00000- 1272.00000	INFINITY 2256.00000	IP2 XP1R1	LL LL
41	XP3R1	LL	.	4500.00000	. NONE	25999.99609- 9999.99609	2244.00000- 2244.00000	INFINITY 2256.00000	IP3 XP1R1	LL LL
42	XP7R1	LL	.	4344.00000	. NONE	299999.93750- 9999.99609	2088.00000- 2088.00000	INFINITY 2256.00000	IP7 XP1R1	LL LL
43	XP10R1	LL	.	4648.00000	. NONE	4999.99609- 9999.99609	1176.00000- 1176.00000	INFINITY 3472.00000	IP8 XP1R1	LL LL
44	XP11R1	LL	.	4920.00000	. NONE	7999.99609- 7000.00000	416.00000- 416.00000	INFINITY 4504.00000	XP12R11 XP11R11	LL LL
45	XP1R2	LL	.	2320.00000	. NONE	109999.93750- 1999.99976	1232.00000- 1232.00000	INFINITY 1088.00000	IP1 XP3R2	LL LL
47	XP4R2	LL	.	2480.00000	. NONE	59999.99609- 1999.99976	1392.00000- 1392.00000	INFINITY 1088.00000	IP4 XP3R2	LL LL
48	XP5R2	LL	.	3000.00000	. NONE	29999.99609- 1999.99976	1912.00000- 1912.00000	INFINITY 1088.00000	IP5 XP3R2	LL LL
49	XP6R2	LL	.	3500.00000	. NONE	14999.99609- 1999.99976	2412.00000- 2412.00000	INFINITY 1088.00000	IP6 XP3R2	LL LL
50	XP7R2	LL	.	3608.00000	. NONE	299999.93750- 1999.99976	2520.00000- 2520.00000	INFINITY 1088.00000	IP7 XP3R2	LL LL
51	XP10R2	LL	.	3912.00000	. NONE	4999.99609- 1999.99976	1607.99976- 1607.99976	INFINITY 2304.00024	IP8 XP3R2	LL LL
52	XP11R2	LL	.	4192.00000	. NONE	7999.99609- 1999.99976	856.00000- 856.00000	INFINITY 3336.00000	XP12R11 XP3R2	LL LL
53	XP1R3	LL	.	2880.00000	. NONE	109999.93750- 4999.99609	1392.00000- 1392.00000	INFINITY 1488.00000	IP1 XP3R3	LL LL
55	XP4R3	LL	.	3272.00000	. NONE	59999.99609- 4999.99609	1784.00000- 1784.00000	INFINITY 1488.00000	IP4 XP3R3	LL LL
56	XP5R3	LL	.	6500.00000	. NONE	29999.99609- 4999.99609	5012.00000- 5012.00000	INFINITY 1488.00000	IP5 XP3R3	LL LL
57	XP6R3	LL	.	6750.00000	. NONE	14999.99609- 4999.99609	5262.00000- 5262.00000	INFINITY 1488.00000	IP6 XP3R3	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
58	XP7R3	LL	.	3696.00000	.	299999.93750-	2208.00000-	INFINITY	IP7	LL
					NONE	4999.99609	2208.00000	1488.00000	XP3R3	LL
59	XP10R3	LL	.	4016.00000	.	4999.99609-	1311.99976-	INFINITY	IP8	LL
					NONE	4999.99609	1311.99976	2704.00024	XP3R3	LL
60	XP11R3	LL	.	4560.00000	.	7999.99609-	824.00000-	INFINITY	XP12R11	LL
					NONE	4999.99609	824.00000	3736.00000	XP3R3	LL
61	XP1R4	LL	.	2944.00000	.	7000.00000-	1615.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	1615.99976	1328.00024	XP12R11	LL
62	XP3R4	LL	.	2048.00000	.	7000.00000-	719.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	719.99976	1328.00024	XP12R11	LL
63	XP4R4	LL	.	2224.00000	.	7000.00000-	895.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	895.99976	1328.00024	XP12R11	LL
64	XP5R4	LL	.	2008.00000	.	7000.00000-	679.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	679.99976	1328.00024	XP12R11	LL
65	XP6R4	LL	.	2528.00000	.	7000.00000-	1199.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	1199.99976	1328.00024	XP12R11	LL
66	XP7R4	LL	.	3112.00000	.	7000.00000-	1783.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	1783.99976	1328.00024	XP12R11	LL
67	XP10R4	LL	.	3408.00000	.	4999.99609-	863.99976-	INFINITY	IP8	LL
					NONE	7999.99609	863.99976	2544.00024	XP12R11	LL
69	XP1R5	LL	.	2336.00000	.	109999.93750-	1656.00000-	INFINITY	IP1	LL
					NONE	4999.99609	1656.00000	680.00000	XP3R5	LL
71	XP4R5	LL	.	2944.00000	.	59999.99609-	2264.00000-	INFINITY	IP4	LL
					NONE	4999.99609	2264.00000	680.00000	XP3R5	LL
72	XP5R5	LL	.	6000.00000	.	29999.99609-	5320.00000-	INFINITY	IP5	LL
					NONE	4999.99609	5320.00000	680.00000	XP3R5	LL
73	XP6R5	LL	.	6250.00000	.	14999.99609-	5570.00000-	INFINITY	IP6	LL
					NONE	4999.99609	5570.00000	680.00000	XP3R5	LL
74	XP7R5	LL	.	3416.00000	.	299999.93750-	2736.00000-	INFINITY	IP7	LL
					NONE	4999.99609	2736.00000	680.00000	XP3R5	LL
75	XP10R5	LL	.	3720.00000	.	4999.99609-	1823.99976-	INFINITY	IP8	LL
					NONE	4999.99609	1823.99976	1896.00024	XP3R5	LL
76	XP11R5	LL	.	3944.00000	.	7999.99609-	1016.00000-	INFINITY	XP12R11	LL
					NONE	4999.99609	1016.00000	2928.00000	XP3R5	LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
77	XP2R6	LL	.	1992.00000	. NONE	7000.00000- 7999.99609	607.99976- 607.99976	INFINITY 1384.00024	XP11R11 XP12R11	LL LL
78	XP4R6	LL	.	3368.00000	. NONE	7000.00000- 7999.99609	1983.99976- 1983.99976	INFINITY 1384.00024	XP11R11 XP12R11	LL LL
79	XP5R6	LL	.	2200.00000	. NONE	7000.00000- 7999.99609	815.99976- 815.99976	INFINITY 1384.00024	XP11R11 XP12R11	LL LL
80	XP6R6	LL	.	2776.00000	. NONE	7000.00000- 7999.99609	1391.99976- 1391.99976	INFINITY 1384.00024	XP11R11 XP12R11	LL LL
81	XP7R6	LL	.	2824.00000	. NONE	7000.00000- 7999.99609	1439.99976- 1439.99976	INFINITY 1384.00024	XP11R11 XP12R11	LL LL
82	XP10R6	LL	.	3312.00000	. NONE	4999.99609- 7999.99609	711.99976- 711.99976	INFINITY 2600.00024	IP8 XP12R11	LL LL
84	XP1R7	LL	.	4224.00000	. NONE	7000.00000- 7999.99609	2775.99976- 2775.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
85	XP3R7	LL	.	4500.00000	. NONE	7000.00000- 7999.99609	3051.99976- 3051.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
86	XP4R7	LL	.	2288.00000	. NONE	7000.00000- 7999.99609	839.99976- 839.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
87	XP5R7	LL	.	2376.00000	. NONE	7000.00000- 7999.99609	927.99976- 927.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
88	XP6R7	LL	.	2776.00000	. NONE	7000.00000- 7999.99609	1327.99976- 1327.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
89	XP7R7	LL	.	3232.00000	. NONE	7000.00000- 7999.99609	1783.99976- 1783.99976	INFINITY 1448.00024	XP11R11 XP12R11	LL LL
90	XP10R7	LL	.	3536.00000	. NONE	4999.99609- 7999.99609	871.99976- 871.99976	INFINITY 2664.00024	IP8 XP12R11	LL LL
92	XP2R8	LL	.	3216.00000	. NONE	7000.00000- 7999.99609	2215.99976- 2215.99976	INFINITY 1000.00024	XP11R11 XP12R11	LL LL
93	XP4R8	LL	.	3040.00000	. NONE	7000.00000- 7999.99609	2039.99976- 2039.99976	INFINITY 1000.00024	XP11R11 XP12R11	LL LL
94	XP5R8	LL	.	6100.00000	. NONE	7000.00000- 7999.99609	5099.99609- 5099.99609	INFINITY 1000.00391	XP11R11 XP12R11	LL LL
95	XP6R8	LL	.	6300.00000	. NONE	7000.00000- 7999.99609	5299.99609- 5299.99609	INFINITY 1000.00391	XP11R11 XP12R11	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
96	XP7R8	LL	.	1304.00000	. NONE	7000.00000- 7999.99609	303.99976- 303.99976	INFINITY 1000.00024	XP11R11 XP12R11	LL LL
97	XP10R8	LL	.	2656.00000	. NONE	4999.99609- 7999.99609	439.99976- 439.99976	INFINITY 2216.00024	IP8 XP12R11	LL LL
99	XP7R9	LL	.	3264.00000	. NONE	7000.00000- 7999.99609	3231.99976- 3231.99976	INFINITY 32.00024	XP11R11 XP12R11	LL LL
100	XP8R9	LL	.	2960.00000	. NONE	4999.99609- 7999.99609	2927.99976- 2927.99976	INFINITY 32.00024	IP8 XP12R11	LL LL
101	XP9R9	LL	.	3400.00000	. NONE	7000.00000- 7999.99609	3367.99976- 3367.99976	INFINITY 32.00024	XP11R11 XP12R11	LL LL
102	XP10R9	LL	.	2688.00000	. NONE	4999.99609- 7999.99609	1439.99976- 1439.99976	INFINITY 1248.00024	IP8 XP12R11	LL LL
104	XP12R9	LL	.	2624.00000	. NONE	7000.00000- 7999.99609	2591.99976- 2591.99976	INFINITY 32.00024	XP11R11 XP12R11	LL LL
105	XP13R9	LL	.	2840.00000	. NONE	7000.00000- 7999.99609	2807.99976- 2807.99976	INFINITY 32.00024	XP11R11 XP12R11	LL LL
106	XS2R9	LL	.	4750.00000	. NONE	7000.00000- 7999.99609	2525.99976- 2525.99976	INFINITY 2224.00024	XP11R11 XP12R11	LL LL
107	XS3R9	LL	.	5000.00000	. NONE	9999.99609- 9999.99609	3240.00000- 3240.00000	INFINITY 1760.00000	XP11R15 XS3R15	LL LL
108	XP7R10	LL	.	4552.00000	. NONE	7000.00000- 5999.99609	2863.99976- 2863.99976	INFINITY 1688.00024	XP11R11 XP11R10	LL LL
109	XP8R10	LL	.	5000.00000	. NONE	4999.99609- 5999.99609	3311.99976- 3311.99976	INFINITY 1688.00024	IP8 XP11R10	LL LL
110	XP9R10	LL	.	5000.00000	. NONE	7000.00000- 5999.99609	3311.99976- 3311.99976	INFINITY 1688.00024	XP11R11 XP11R10	LL LL
111	XP10R10	LL	.	4368.00000	. NONE	4999.99609- 5999.99609	1463.99976- 1463.99976	INFINITY 2904.00024	IP8 XP11R10	LL LL
113	XP12R10	LL	.	2888.00000	. NONE	7000.00000- 5999.99609	1199.99976- 1199.99976	INFINITY 1688.00024	XP11R11 XP11R10	LL LL
114	XP13R10	LL	.	3408.00000	. NONE	7000.00000- 5999.99609	1719.99976- 1719.99976	INFINITY 1688.00024	XP11R11 XP11R10	LL LL
115	XP14R10	LL	.	3784.00000	. NONE	7000.00000- 5999.99609	2095.99976- 2095.99976	INFINITY 1688.00024	XP11R11 XP11R10	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
116	XS2R10	LL	.	5000.00000	. NONE	7000.00000- 5999.99609	1119.99976- 1119.99976	INFINITY 3880.00024	XP11R11 XP11R10	LL LL
117	XS3R10	LL	.	5000.00000	. NONE	9999.99609- 5999.99609	1584.00000- 1584.00000	INFINITY 3416.00000	XP11R15 XP11R10	LL LL
118	XP7R11	LL	.	4080.00000	. NONE	299999.93750- 7999.99609	3000.00000- 3000.00000	INFINITY 1080.00000	IP7 XP12R11	LL LL
119	XP8R11	LL	.	3600.00000	. NONE	4999.99609- 7999.99609	2520.00000- 2520.00000	INFINITY 1080.00000	IP8 XP12R11	LL LL
120	XP9R11	LL	.	3928.00000	. NONE	29999.99609- 7999.99609	2848.00000- 2848.00000	INFINITY 1080.00000	IP9 XP12R11	LL LL
121	XP10R11	LL	.	3536.00000	. NONE	4999.99609- 7999.99609	1240.00000- 1240.00000	INFINITY 2296.00000	IP8 XP12R11	LL LL
124	XP13R11	LL	.	2632.00000	. NONE	39999.99609- 7999.99609	1552.00000- 1552.00000	INFINITY 1080.00000	IP13 XP12R11	LL LL
125	XP14R11	LL	.	3544.00000	. NONE	44999.99609- 7999.99609	2464.00000- 2464.00000	INFINITY 1080.00000	IP14 XP12R11	LL LL
126	XS2R11	LL	.	5000.00000	. NONE	39999.99609- 7999.99609	1728.00000- 1728.00000	INFINITY 3272.00000	IP13 XP12R11	LL LL
127	XS3R11	LL	.	5250.00000	. NONE	9999.99609- 7000.00000	2442.00000- 2442.00000	INFINITY 2808.00000	XP11R15 XP11R11	LL LL
128	XP7R12	LL	.	3984.00000	. NONE	7000.00000- 7999.99609	2863.99976- 2863.99976	INFINITY 1120.00024	XP11R11 XP12R11	LL LL
129	XP8R12	LL	.	6000.00000	. NONE	4999.99609- 7999.99609	4879.99609- 4879.99609	INFINITY 1120.00391	IP8 XP12R11	LL LL
130	XP10R12	LL	.	3584.00000	. NONE	4999.99609- 7999.99609	1247.99976- 1247.99976	INFINITY 2336.00024	IP8 XP12R11	LL LL
132	XP12R12	LL	.	1800.00000	. NONE	7000.00000- 7999.99609	679.99976- 679.99976	INFINITY 1120.00024	XP11R11 XP12R11	LL LL
133	XP13R12	LL	.	2600.00000	. NONE	7000.00000- 7999.99609	1479.99976- 1479.99976	INFINITY 1120.00024	XP11R11 XP12R11	LL LL
134	XP14R12	LL	.	3064.00000	. NONE	7000.00000- 7999.99609	1943.99976- 1943.99976	INFINITY 1120.00024	XP11R11 XP12R11	LL LL
135	XS2R12	LL	.	4600.00000	. NONE	7000.00000- 7999.99609	1287.99976- 1287.99976	INFINITY 3312.00024	XP11R11 XP12R11	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
136	XS3R12	LL	.	3120.00000	. NONE	9999.99609- 9999.99609	271.99976- 271.99976	INFINITY 2848.00024	XP11R15 XS3R15	LL LL
137	XP7R13	LL	.	5360.00000	. NONE	7000.00000- 7999.99609	3055.99976- 3055.99976	INFINITY 2304.00024	XP11R11 XP12R11	LL LL
138	XP8R13	LL	.	7500.00000	. NONE	4999.99609- 7999.99609	5195.99609- 5195.99609	INFINITY 2304.00391	IP8 XP12R11	LL LL
139	XP10R13	LL	.	7250.00000	. NONE	4999.99609- 7999.99609	3729.99976- 3729.99976	INFINITY 3520.00024	IP8 XP12R11	LL LL
141	XP12R13	LL	.	7500.00000	. NONE	7000.00000- 7999.99609	5196.00000- 5196.00000	INFINITY 2304.00000	XP11R11 XP12R11	LL LL
142	XP13R13	LL	.	4500.00000	. NONE	7000.00000- 7999.99609	2195.99976- 2195.99976	INFINITY 2304.00024	XP11R11 XP12R11	LL LL
143	XP14R13	LL	.	2624.00000	. NONE	7000.00000- 7999.99609	319.99976- 319.99976	INFINITY 2304.00024	XP11R11 XP12R11	LL LL
144	XS2R13	LL	.	7000.00000	. NONE	7000.00000- 7999.99609	2503.99976- 2503.99976	INFINITY 4496.00024	XP11R11 XP12R11	LL LL
145	XS3R13	LL	.	7100.00000	. NONE	9999.99609- 9999.99609	3068.00000- 3068.00000	INFINITY 4032.00000	XP11R15 XS3R15	LL LL
146	XP7R14	LL	.	4456.00000	. NONE	7000.00000- 7999.99609	2951.99976- 2951.99976	INFINITY 1504.00024	XP11R11 XP12R11	LL LL
147	XP8R14	LL	.	6200.00000	. NONE	4999.99609- 7999.99609	4695.99609- 4695.99609	INFINITY 1504.00391	IP8 XP12R11	LL LL
148	XP10R14	LL	.	6100.00000	. NONE	4999.99609- 7999.99609	3379.99976- 3379.99976	INFINITY 2720.00024	IP8 XP12R11	LL LL
150	XP12R14	LL	.	6000.00000	. NONE	7000.00000- 7999.99609	4496.00000- 4496.00000	INFINITY 1504.00000	XP11R11 XP12R11	LL LL
151	XP13R14	LL	.	2736.00000	. NONE	7000.00000- 7999.99609	1231.99976- 1231.99976	INFINITY 1504.00024	XP11R11 XP12R11	LL LL
152	XP14R14	LL	.	5000.00000	. NONE	7000.00000- 7999.99609	3495.99976- 3495.99976	INFINITY 1504.00024	XP11R11 XP12R11	LL LL
153	XP15R14	LL	.	5500.00000	. NONE	7000.00000- 7999.99609	3995.99976- 3995.99976	INFINITY 1504.00024	XP11R11 XP12R11	LL LL
154	XS2R14	LL	.	5750.00000	. NONE	7000.00000- 7999.99609	2053.99976- 2053.99976	INFINITY 3696.00024	XP11R11 XP12R11	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
155	XS3R14	LL	.	5500.00000	. NONE	9999.99609- 8999.99609	2268.00000- 2268.00000	INFINITY 3232.00000	XP11R15 XP11R14	LL LL
156	XP7R15	LL	.	4320.00000	. NONE	7000.00000- 7999.99609	3031.99976- 3031.99976	INFINITY 1288.00024	XP11R11 XP12R11	LL LL
158	XP13R15	LL	.	3112.00000	. NONE	7000.00000- 7999.99609	1823.99976- 1823.99976	INFINITY 1288.00024	XP11R11 XP12R11	LL LL
159	XS2R15	LL	.	4500.00000	. NONE	7000.00000- 7999.99609	1019.99976- 1019.99976	INFINITY 3480.00024	XP11R11 XP12R11	LL LL
161	XP7R16	LL	.	5136.00000	. NONE	7000.00000- 7999.99609	2943.99976- 2943.99976	INFINITY 2192.00024	XP11R11 XP12R11	LL LL
163	XP13R16	LL	.	3640.00000	. NONE	7000.00000- 7999.99609	1447.99976- 1447.99976	INFINITY 2192.00024	XP11R11 XP12R11	LL LL
164	XP14R16	LL	.	2248.00000	. NONE	7000.00000- 7999.99609	55.99998- 55.99998	INFINITY 2192.00002	XP11R11 XP12R11	LL LL
165	XP15R16	LL	.	2576.00000	. NONE	7000.00000- 7999.99609	383.99976- 383.99976	INFINITY 2192.00024	XP11R11 XP12R11	LL LL
166	XP7R17	LL	.	5528.00000	. NONE	7000.00000- 6999.99609	2869.99976- 2869.99976	INFINITY 2658.00024	XP11R11 XP11R17	LL LL
168	XP12R17	LL	.	8000.00000	. NONE	7000.00000- 6999.99609	5342.00000- 5342.00000	INFINITY 2658.00000	XP11R11 XP11R17	LL LL
169	XP13R17	LL	.	3984.00000	. NONE	7000.00000- 6999.99609	1325.99976- 1325.99976	INFINITY 2658.00024	XP11R11 XP11R17	LL LL
170	XP14R17	LL	.	3112.00000	. NONE	7000.00000- 6999.99609	453.99976- 453.99976	INFINITY 2658.00024	XP11R11 XP11R17	LL LL
171	XP15R17	LL	.	2680.00000	. NONE	7000.00000- 6999.99609	21.99998- 21.99998	INFINITY 2658.00002	XP11R11 XP11R17	LL LL
172	XP7R18	LL	.	15000.00000	. NONE	7000.00000- 7999.99609	11431.99609- 11431.99609	INFINITY 3568.00391	XP11R11 XP12R11	LL LL
174	XP13R18	LL	.	4632.00000	. NONE	7000.00000- 7999.99609	1063.99976- 1063.99976	INFINITY 3568.00024	XP11R11 XP12R11	LL LL
175	XP14R18	LL	.	10000.00000	. NONE	7000.00000- 7999.99609	6431.99609- 6431.99609	INFINITY 3568.00391	XP11R11 XP12R11	LL LL
176	XP15R18	LL	.	3680.00000	. NONE	7000.00000- 7999.99609	111.99998- 111.99998	INFINITY 3568.00002	XP11R11 XP12R11	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
177	XP7R19	LL	.	6672.00000	.	7000.00000-	2711.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	2711.99976	3960.00024	XP12R11	LL
179	XP13R19	LL	.	5248.00000	.	7000.00000-	1287.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	1287.99976	3960.00024	XP12R11	LL
180	XP14R19	LL	.	10500.00000	.	7000.00000-	6539.99609-	INFINITY	XP11R11	LL
					NONE	7999.99609	6539.99609	3960.00391	XP12R11	LL
181	XP15R19	LL	.	4179.00000	.	7000.00000-	218.99998-	INFINITY	XP11R11	LL
					NONE	7999.99609	218.99998	3960.00002	XP12R11	LL
182	XP10P3	LL	.	3880.00000	.	4999.99609-	2663.99976-	INFINITY	IP8	LL
					NONE	25999.99609	2663.99976	1216.00024	IP3	LL
183	XP10P4	LL	.	3216.00000	.	4999.99609-	1999.99976-	INFINITY	IP8	LL
					NONE	29999.99609	1999.99976	1216.00024	XP10P8	LL
184	XP10P5	LL	.	2928.00000	.	4999.99609-	1711.99976-	INFINITY	IP8	LL
					NONE	29999.99609	1711.99976	1216.00024	XP10P8	LL
185	XP10P6	LL	.	2632.00000	.	4999.99609-	1415.99976-	INFINITY	IP8	LL
					NONE	14999.99609	1415.99976	1216.00024	IP6	LL
186	XP10P7	LL	.	2096.00000	.	4999.99609-	879.99976-	INFINITY	IP8	LL
					NONE	29999.99609	879.99976	1216.00024	XP10P8	LL
188	XP10P9	LL	.	3160.00000	.	4999.99609-	1943.99976-	INFINITY	IP8	LL
					NONE	29999.99609	1943.99976	1216.00024	XP10P8	LL
189	XP11P1	LL	.	4552.00000	.	7999.99609-	2304.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	2304.00000	2248.00000	XP11R11	LL
190	XP11P2	LL	.	4152.00000	.	7999.99609-	1904.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	1904.00000	2248.00000	XP11R11	LL
191	XP11P3	LL	.	4120.00000	.	7999.99609-	1872.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	1872.00000	2248.00000	XP11R11	LL
192	XP11P4	LL	.	3536.00000	.	7999.99609-	1288.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	1288.00000	2248.00000	XP11R11	LL
193	XP11P5	LL	.	3624.00000	.	7999.99609-	1376.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	1376.00000	2248.00000	XP11R11	LL
194	XP11P6	LL	.	3072.00000	.	7999.99609-	824.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	824.00000	2248.00000	XP11R11	LL
195	XP11P7	LL	.	2912.00000	.	7999.99609-	664.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	664.00000	2248.00000	XP11R11	LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
196	XP11P8	LL	.	2336.00000	.	7999.99609-	88.00000-	INFINITY	XP12R11	LL
					NONE	4999.99609	88.00000	2248.00000	IP8	LL
197	XP11P9	LL	.	3344.00000	.	7999.99609-	1096.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	1096.00000	2248.00000	XP11R11	LL
198	XP11P12	LL	.	3216.00000	.	7999.99609-	968.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	968.00000	2248.00000	XP11R11	LL
199	XS2P12	LL	.	5552.00000	.	39999.99609-	3360.00000-	INFINITY	IP13	LL
					NONE	9999.99609	3360.00000	2192.00000	XS2P13	LL
200	XS3P12	LL	.	3016.00000	.	7999.99609-	1287.99976-	INFINITY	XP12R11	LL
					NONE	7000.00000	1287.99976	1728.00024	XP11R11	LL
201	XP11P13	LL	.	3160.00000	.	7999.99609-	912.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	912.00000	2248.00000	XP11R11	LL
203	XS3P13	LL	.	2432.00000	.	7999.99609-	704.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	704.00000	1728.00000	XP11R11	LL
204	XP11P14	LL	.	4672.00000	.	7999.99609-	2424.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	2424.00000	2248.00000	XP11R11	LL
205	XP11P15	LL	.	6208.00000	.	7999.99609-	3960.00000-	INFINITY	XP12R11	LL
					NONE	7000.00000	3960.00000	2248.00000	XP11R11	LL
215	IP10	LL	.	3000.00000	.	29999.99609-	1216.00000-	INFINITY	XP10P8	LL
					NONE	4999.99609	1216.00000	1784.00000	IP8	LL
216	IP11	LL	.	3000.00000	.	7000.00000-	2247.99976-	INFINITY	XP11R11	LL
					NONE	7999.99609	2247.99976	752.00024	XP12R11	LL

SECTION 3 - ROWS AT INTERMEDIATE LEVEL

	Column 1		Column 2	Column 3	Column 4	Column 5	Column 6		Column 7	
NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
31	MBP11	BS	200000.00000		NONE 200J00.00000	2CGOCG.00000 207999.99609	INFINITY 55.99998		NONE MBS2	 UL

CTION 4 - COLUMNS AT INTERMEDIATE LEVEL

	Column 1		Column 2	Column 3		Column 4	Column 5	Column 6	Column 7	
UMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
39	XP1R1	BS	9999.99609	2256.00000	. NONE	3000.00000 9999.99609	416.00000 INFINITY	2672.00000 INFINITY-	XP11R1 NONE	LL
46	XP3R2	BS	1999.99976	1088.00000	. NONE	4999.99634- 1999.99976	856.00000 INFINITY	1944.00000 INFINITY-	XP11R2 NONE	LL
54	XP3R3	BS	4999.99609	1488.00000	. NONE	2000.00000- 4999.99609	824.00000 INFINITY	2312.00000 INFINITY-	XP11R3 NONE	LL
68	XP11R4	BS	15999.99609	3576.00000	. NONE	8000.00391 15999.99609	679.99976 INFINITY	4255.99976 INFINITY-	XP5R4 NONE	LL
70	XP3R5	BS	4999.99609	680.00000	. NONE	2000.00000- 4999.99609	1016.00000 INFINITY	1696.00000 INFINITY-	XP11R5 NONE	LL
83	XP11R6	BS	11999.99609	3632.00000	. NONE	4000.00391 11999.99609	607.99976 INFINITY	4239.99976 INFINITY-	XP2R6 NONE	LL
91	XP11R7	BS	27999.99609	3696.00000	. NONE	20000.00391 27999.99609	839.99976 INFINITY	4535.99976 INFINITY-	XP4R7 NONE	LL
98	XP11R8	BS	14999.99609	3248.00000	. NONE	7000.00391 14999.99609	303.99976 INFINITY	3551.99976 INFINITY-	XP7R8 NONE	LL
103	XP11R9	BS	21999.99609	2280.00000	. NONE	14000.00391 21999.99609	1439.99976 INFINITY	3719.99976 INFINITY-	XP10R9 NONE	LL
112	XP11R10	BS	5999.99609	3936.00000	. NONE	1999.99609- 5999.99609	1119.99976 INFINITY	5055.99976 INFINITY-	XS2R10 NONE	LL
122	XP11R11	BS	7000.00000	3328.00000	. NONE	2000.00781 13999.99219	88.00000 21.99998	3416.00000 3306.00002	XP11P8 XP15R17	LL LL
123	XP12R11	BS	7999.99609	1080.00000	. NONE	1000.00391 12999.98828	21.99998 88.00000	1101.99998 992.00000	XP15R17 XP11P8	LL LL
131	XP11R12	BS	9999.99609	3368.00000	. NONE	 9999.99609	271.99976 INFINITY	3639.99976 INFINITY-	XS3R12 NONE	LL
140	XP11R13	BS	9999.99609	4552.00000	. NONE	2000.00391 9999.99609	319.99976 INFINITY	4871.99976 INFINITY-	XP14R13 NONE	LL
149	XP11R14	BS	8999.99609	3752.00000	. NONE	1000.00391 8999.99609	1231.99976 INFINITY	4983.99976 INFINITY-	XP13R14 NONE	LL
157	XP11R15	BS	9999.99609	3536.00000	. NONE	2000.00391 19999.98828	1019.99976 271.99976	4555.99976 3264.00024	XS2R15 XS3R12	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
160	XS3R15	BS	9999.99609	3016.00000	. NONE	 9999.99609	271.99976 INFINITY	3287.99976 INFINITY-	XS3R12 NONE	LL
162	XP11R16	BS	9999.99609	4440.00000	. NONE	2000.00391 9999.99609	55.99998 INFINITY	4495.99998 INFINITY-	XP14R16 NONE	LL
167	XP11R17	BS	6999.99609	4906.00000	. NONE	999.99609- 6999.99609	21.99998 INFINITY	4927.99998 INFINITY-	XP15R17 NONE	LL
173	XP11R18	BS	12999.99609	5816.00000	. NONE	5000.00391 12999.99609	111.99998 INFINITY	5927.99998 INFINITY-	XP15R18 NONE	LL
178	XP11R19	BS	24999.99609	6208.00000	. NONE	17000.00391 24999.99609	218.99998 INFINITY	6426.99998 INFINITY-	XP15R19 NONE	LL
187	XP10P8	BS	29999.99609	1216.00000	. NONE	22000.00391 34999.98828	439.99976 1216.00000	1655.99976 	XP10R8 IP10	LL LL
202	XS2P13	BS	9999.99609	2192.00000	. NONE	9999.99609 9999.99609	55.99998 INFINITY	2247.99998 INFINITY-	MBS2 NONE	UL
206	IP1	BS	109999.93750	3000.00000	. NONE	102999.94141 111999.93701	416.00000 1232.00000	3416.00000 1768.00000	XP11R1 XP1R2	LL LL
207	IP2	BS	27999.99609	3000.00000	. NONE	21000.00000 35999.98828	1904.00000 607.99976	4904.00000 2392.00024	XP11P2 XP2R6	LL LL
208	IP3	BS	25999.99609	3000.00000	. NONE	21000.00391 33999.98828	824.00000 719.99976	3824.00000 2280.00024	XP11R3 XP3R4	LL LL
209	IP4	BS	59999.99609	3000.00000	. NONE	53000.00000 67999.98828	1288.00000 839.99976	4288.00000 2160.00024	XP11P4 XP4R7	LL LL
210	IP5	BS	29999.99609	3000.00000	. NONE	23000.00000 37999.98828	1376.00000 679.99976	4376.00000 2320.00024	XP11P5 XP5R4	LL LL
211	IP6	BS	14999.99609	3000.00000	. NONE	8000.00000 22999.98828	824.00000 1199.99976	3824.00000 1800.00024	XP11P6 XP6R4	LL LL
212	IP7	BS	299999.93750	3000.00000	. NONE	292999.94141 307999.92969	664.00000 303.99976	3664.00000 2696.00024	XP11P7 XP7R8	LL LL
213	IP8	BS	4999.99609	3000.00000	. NONE	2000.00000- 12999.98828	88.00000 439.99976	3088.00000 2560.00024	XP11P8 XP10R8	LL LL
214	IP9	BS	29999.99609	3000.00000	. NONE	23000.00000 37999.98828	1096.00000 2848.00000	4096.00000 152.00000	XP11P9 XP9R11	LL LL
217	IP12	BS	22999.99609	3000.00000	. NONE	16000.00391 27999.98828	21.99998 88.00000	3021.99998 2912.00000	XP15R17 XP11P8	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
218	IP13	BS	39999.99609	3000.00000	. NONE	33000.00000 39999.99609	704.00000 55.99998	3704.00000 2944.00002	XS3P13 MBS2	LL UL
219	IP14	BS	44999.99609	3000.00000	. NONE	38000.00000 52999.98828	2424.00000 55.99998	5424.00000 2944.00002	XP11P14 XP14R16	LL LL
220	IP15	BS	19999.99609	3000.00000	. NONE	13000.00000 26999.98828	3960.00000 21.99998	6960.00000 2978.00002	XP11P15 XP15R17	LL LL

Appendix II.

The capacitated distribution network solutions.

```
0001                PROGRAM
0002                INITIALZ
0065                MOVE(XDATA,'EXAMPLE')
0066                MOVE(XPBNAME,'PBFILE')
0067                CONVERT('SUMMARY')
0068                BCDOUT
0069                SETUP('BOUND','SHIPCAP','MIN')
0070                MOVE(XOBJ,'COST')
0071                MOVE(XRHS,'RHS1')
0072                PICTURE
0073                PRIMAL
0074                SOLUTION
0075                RANGE
0076                EXIT
0077                PEND
```

```
CONVERT EXAMPLE TO PBFILE
TIME =   0.01
     SUMMARY

1- ROWS SECTION.

   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
2- COLUMNS SECTION.

   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
3- RHS'S SECTION.
  RHS1
   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
5- BOUNDS SECTION.
  SHIPCAP
   0 MINOR ERROR(S) -   0 MAJOR ERROR(S).
```

```
NAME          EXAMPLE
ROWS
 N  COST
 E  MBR1
 E  MBR2
 E  MBR3
 E  MBR4
 E  MBR5
 E  MBR6
 E  MBR7
 E  MBR8
 E  MBR9
 E  MBR10
 E  MBR11
 E  MBR12
 E  MBR13
 E  MBR14
 E  MBR15
 E  MBR16
 E  MBR17
 E  MBR18
 E  MBR19
 E  MBP1
 E  MBP2
 E  MBP3
 E  MBP4
 E  MBP5
 E  MBP6
 E  MBP7
 E  MBP8
 E  MBP9
 L  MBP10
 L  MBP11
 E  MBP12
 E  MBP13
 E  MBP14
 E  MBP15
 L  MBS2
 L  MBS3
 E  TOTDEM
COLUMNS
    XP1R1     COST         2256.00000   MBR1           1.00000
    XP1R1     MBP1      -     1.00000
    XP2R1     COST         3528.00000   MBR1           1.00000
    XP2R1     MBP2      -     1.00000
    XP3R1     COST         4500.00000   MBR1           1.00000
    XP3R1     MBP3      -     1.00000
    XP7R1     COST         4344.00000   MBR1           1.00000
    XP7R1     MBP7      -     1.00000
    XP10R1    COST         4648.00000   MBP10          1.00000
    XP10R1    MBR1            1.00000
    XP11R1    COST         4920.00000   MBP11          1.00000
    XP11R1    MBR1            1.00000
    XP1R2     COST         2320.00000   MBR2           1.00000
```

XP1R2	MBP1	-	1.00000		
XP3R2	COST		1088.00000	MBR2	1.00000
XP3R2	MBP3	-	1.00000		
XP4R2	COST		2480.00000	MBR2	1.00000
XP4R2	MBP4	-	1.00000		
XP5R2	COST		3000.00000	MBR2	1.00000
XP5R2	MBP5	-	1.00000		
XP6R2	COST		3500.00000	MBR2	1.00000
XP6R2	MBP6	-	1.00000		
XP7R2	COST		3608.00000	MBR2	1.00000
XP7R2	MBP7	-	1.00000		
XP10R2	COST		3912.00000	MBP10	1.00000
XP10R2	MBR2		1.00000		
XP11R2	COST		4192.00000	MBP11	1.00000
XP11R2	MBR2		1.00000		
XP1R3	COST		2880.00000	MBR3	1.00000
XP1R3	MBP1	-	1.00000		
XP3R3	COST		1488.00000	MBR3	1.00000
XP3R3	MBP3	-	1.00000		
XP4R3	COST		3272.00000	MBR3	1.00000
XP4R3	MBP4	-	1.00000		
XP5R3	COST		6500.00000	MBR3	1.00000
XP5R3	MBP5	-	1.00000		
XP6R3	COST		6750.00000	MBR3	1.00000
XP6R3	MBP6	-	1.00000		
XP7R3	COST		3696.00000	MBR3	1.00000
XP7R3	MBP7	-	1.00000		
XP10R3	COST		4016.00000	MBP10	1.00000
XP10R3	MBR3		1.00000		
XP11R3	COST		4560.00000	MBP11	1.00000
XP11R3	MBR3		1.00000		
XP1R4	COST		2944.00000	MBR4	1.00000
XP1R4	MBP1	-	1.00000		
XP3R4	COST		2048.00000	MBR4	1.00000
XP3R4	MBP3	-	1.00000		
XP4R4	COST		2224.00000	MBR4	1.00000
XP4R4	MBP4	-	1.00000		
XP5R4	COST		2008.00000	MBR4	1.00000
XP5R4	MBP5	-	1.00000		
XP6R4	COST		2528.00000	MBR4	1.00000
XP6R4	MBP6	-	1.00000		
XP7R4	COST		3112.00000	MBR4	1.00000
XP7R4	MBP7	-	1.00000		
XP10R4	COST		3408.00000	MBP10	1.00000
XP10R4	MBR4		1.00000		
XP11R4	COST		3576.00000	MBP11	1.00000
XP11R4	MBR4		1.00000		
XP1R5	COST		2336.00000	MBR5	1.00000
XP1R5	MBP1	-	1.00000		
XP3R5	COST		1360.00000	MBR5	1.00000
XP3R5	MBP3	-	1.00000		
XP4R5	COST		2944.00000	MBR5	1.00000
XP4R5	MBP4	-	1.00000		
XP5R5	COST		6000.00000	MBR5	1.00000

XP5R5	MBP5	-1.00000		
XP6R5	COST	6250.00000	MBR5	1.00000
XP6R5	MBP6	-1.00000		
XP7R5	COST	3416.00000	MBR5	1.00000
XP7R5	MBP7	-1.00000		
XP10R5	COST	3720.00000	MBP10	1.00000
XP10R5	MBR5	1.00000		
XP11R5	COST	3944.00000	MBP11	1.00000
XP11R5	MBR5	1.00000		
XP2R6	COST	1992.00000	MBR6	1.00000
XP2R6	MBP2	-1.00000		
XP4R6	COST	3368.00000	MBR6	1.00000
XP4R6	MBP4	-1.00000		
XP5R6	MBR6	1.00000	MBP5	-1.00000
XP5R6	COST	2200.00000		
XP6R6	MBR6	1.00000	MBP6	-1.00000
XP6R6	COST	2776.00000		
XP7R6	COST	2824.00000	MBR6	1.00000
XP7R6	MBP7	-1.00000		
XP10R6	COST	3312.00000	MBP10	1.00000
XP10R6	MBR6	1.00000		
XP11R6	COST	3632.00000	MBP11	1.00000
XP11R6	MBR6	1.00000		
XP1R7	MBR7	1.00000	MBP1	-1.00000
XP1R7	COST	4224.00000		
XP3R7	COST	4500.00000	MBR7	1.00000
XP3R7	MBP3	-1.00000		
XP4R7	COST	2288.00000	MBR7	1.00000
XP4R7	MBP4	-1.00000		
XP5R7	COST	2376.00000	MBR7	1.00000
XP5R7	MBP5	-1.00000		
XP6R7	COST	2776.00000	MBR7	1.00000
XP6R7	MBP6	-1.00000		
XP7R7	COST	3232.00000	MBR7	1.00000
XP7R7	MBP7	-1.00000		
XP10R7	COST	3536.00000	MBP10	1.00000
XP10R7	MBR7	1.00000		
XP11R7	COST	3696.00000	MBP11	1.00000
XP11R7	MBR7	1.00000		
XP2R8	COST	3216.00000	MBR8	1.00000
XP2R8	MBP2	-1.00000		
XP4R8	COST	3040.00000	MBR8	1.00000
XP4R8	MBP4	-1.00000		
XP5R8	COST	6100.00000	MBR8	1.00000
XP5R8	MBP5	-1.00000		
XP6R8	COST	6300.00000	MBR8	1.00000
XP6R8	MBP6	-1.00000		
XP7R8	COST	1304.00000	MBR8	1.00000
XP7R8	MBP7	-1.00000		
XP10R8	MBR8	1.00000	COST	2656.00000
XP10R8	MBP10	1.00000		
XP11R8	MBR8	1.00000	COST	3248.00000
XP11R8	MBP11	1.00000		
XP7R9	COST	3264.00000	MBR9	1.00000

XP7R9	MBP7	-	1.00000		
XP8R9	COST		2960.00000	MBR9	1.00000
XP8R9	MBP8	-	1.00000		
XP9R9	COST		3400.00000	MBR9	1.00000
XP9R9	MBP9	-	1.00000		
XP10R9	COST		2688.00000	MBR9	1.00000
XP10R9	MBP10		1.00000		
XP11R9	COST		2280.00000	MBR9	1.00000
XP11R9	MBP11		1.00000		
XP12R9	COST		2624.00000	MBR9	1.00000
XP12R9	MBP12	-	1.00000		
XP13R9	COST		2840.00000	MBR9	1.00000
XP13R9	MBP13	-	1.00000		
XS2R9	COST		4750.00000	MBR9	1.00000
XS2R9	MBS2		1.00000		
XS3R9	COST		5000.00000	MBR9	1.00000
XS3R9	MBS3		1.00000		
XP7R10	COST		4552.00000	MBR10	1.00000
XP7R10	MBP7	-	1.00000		
XP8R10	COST		5000.00000	MBR10	1.00000
XP8R10	MBP8	-	1.00000		
XP9R10	COST		5000.00000	MBR10	1.00000
XP9R10	MBP9	-	1.00000		
XP10R10	COST		4368.00000	MBR10	1.00000
XP10R10	MBP10		1.00000		
XP11R10	COST		3936.00000	MBR10	1.00000
XP11R10	MBP11		1.00000		
XP12R10	COST		2888.00000	MBR10	1.00000
XP12R10	MBP12	-	1.00000		
XP13R10	COST		3408.00000	MBR10	1.00000
XP13R10	MBP13	-	1.00000		
XP14R10	COST		3784.00000	MBR10	1.00000
XP14R10	MBP14	-	1.00000		
XS2R10	COST		5000.00000	MBR10	1.00000
XS2R10	MBS2		1.00000		
XS3R10	COST		5000.00000	MBR10	1.00000
XS3R10	MBS3		1.00000		
XP7R11	COST		4080.00000	MBR11	1.00000
XP7R11	MBP7	-	1.00000		
XP8R11	COST		3600.00000	MBR11	1.00000
XP8R11	MBP8	-	1.00000		
XP9R11	COST		3928.00000	MBR11	1.00000
XP9R11	MBP9	-	1.00000		
XP10P11	COST		3536.00000	MBR11	1.00000
XP10R11	MBP10		1.00000		
XP11R11	COST		3328.00000	MBR11	1.00000
XP11R11	MBP11		1.00000		
XP12R11	COST		1080.00000	MBR11	1.00000
XP12R11	MBP12	-	1.00000		
XP13R11	COST		2632.00000	MBR11	1.00000
XP13R11	MBP13	-	1.00000		
XP14R11	COST		3544.00000	MBR11	1.00000
XP14R11	MBP14	-	1.00000		
XS2R11	COST		5000.00000	MBR11	1.00000

XS2R11	MBS2		1.00000		
XS3R11	COST		5250.00000	MBR11	1.00000
XS3R11	MBS3		1.00000		
XP7R12	COST		3984.00000	MBR12	1.00000
XP7R12	MBP7	-	1.00000		
XP8R12	COST		6000.00000	MBR12	1.00000
XP8R12	MBP8	-	1.00000		
XP10R12	COST		3584.00000	MBR12	1.00000
XP10R12	MBP10		1.00000		
XP11R12	COST		3368.00000	MBR12	1.00000
XP11R12	MBP11		1.00000		
XP12R12	COST		1800.00000	MBR12	1.00000
XP12R12	MBP12	-	1.00000		
XP13R12	COST		2600.00000	MBR12	1.00000
XP13R12	MBP13	-	1.00000		
XP14R12	COST		3064.00000	MBR12	1.00000
XP14R12	MBP14	-	1.00000		
XS2R12	COST		4600.00000	MBR12	1.00000
XS2R12	MBS2		1.00000		
XS3R12	COST		3120.00000	MBR12	1.00000
XS3R12	MBS3		1.00000		
XP7R13	COST		5360.00000	MBR13	1.00000
XP7R13	MBP7	-	1.00000		
XP8R13	COST		7500.00000	MBR13	1.00000
XP8R13	MBP8	-	1.00000		
XP10R13	COST		7250.00000	MBR13	1.00000
XP10R13	MBP10		1.00000		
XP11R13	COST		4552.00000	MBR13	1.00000
XP11R13	MBP11		1.00000		
XP12R13	COST		7500.00000	MBR13	1.00000
XP12R13	MBP12	-	1.00000		
XP13R13	COST		4500.00000	MBR13	1.00000
XP13R13	MBP13	-	1.00000		
XP14R13	COST		2624.00000	MBR13	1.00000
XP14R13	MBP14	-	1.00000		
XS2R13	COST		7000.00000	MBR13	1.00000
XS2R13	MBS2		1.00000		
XS3R13	COST		7100.00000	MBR13	1.00000
XS3R13	MBS3		1.00000		
XP7R14	COST		4456.00000	MBR14	1.00000
XP7R14	MBP7	-	1.00000		
XP8R14	COST		6200.00000	MBR14	1.00000
XP8R14	MBP8	-	1.00000		
XP10R14	COST		6100.00000	MBR14	1.00000
XP10R14	MBP10		1.00000		
XP11R14	COST		3752.00000	MBR14	1.00000
XP11R14	MBP11		1.00000		
XP12R14	COST		6000.00000	MBR14	1.00000
XP12R14	MBP12	-	1.00000		
XP13R14	COST		2736.00000	MBR14	1.00000
XP13R14	MBP13	-	1.00000		
XP14R14	COST		5000.00000	MBR14	1.00000
XP14R14	MBP14	-	1.00000		
XP15R14	COST		5500.00000	MBR14	1.00000

XP15R14	MBP15	-	1.00000		
XS2R14	COST		5750.00000	MBR14	1.00000
XS2R14	MBS2		1.00000		
XS3R14	COST		5500.00000	MBR14	1.00000
XS3R14	MBS3		1.00000		
XP7R15	COST		4320.00000	MBR15	1.00000
XP7R15	MBP7	-	1.00000		
XP11R15	COST		3536.00000	MBR15	1.00000
XP11R15	MBP11		1.00000		
XP13R15	COST		3112.00000	MBR15	1.00000
XP13R15	MBP13	-	1.00000		
XS2R15	COST		4500.00000	MBR15	1.00000
XS2R15	MBS2		1.00000		
XS3R15	COST		3016.00000	MBR15	1.00000
XS3R15	MBS3		1.00000		
XP7R16	COST		5136.00000	MBR16	1.00000
XP7R16	MBP7	-	1.00000		
XP11R16	COST		4440.00000	MBR16	1.00000
XP11R16	MBP11		1.00000		
XP13R16	COST		3640.00000	MBR16	1.00000
XP13R16	MBP13	-	1.00000		
XP14R16	COST		2248.00000	MBR16	1.00000
XP14R16	MBP14	-	1.00000		
XP15R16	COST		2576.00000	MBR16	1.00000
XP15R16	MBP15	-	1.00000		
XP7R17	COST		5528.00000	MBR17	1.00000
XP7R17	MBP7	-	1.00000		
XP11R17	COST		4906.00000	MBR17	1.00000
XP11R17	MBP11		1.00000		
XP12R17	COST		8000.00000	MBR17	1.00000
XP12R17	MBP12	-	1.00000		
XP13R17	COST		3984.00000	MBR17	1.00000
XP13R17	MBP13	-	1.00000		
XP14R17	COST		3112.00000	MBR17	1.00000
XP14R17	MBP14	-	1.00000		
XP15R17	COST		2680.00000	MBR17	1.00000
XP15R17	MBP15	-	1.00000		
XP7R18	COST		15000.00000	MBR18	1.00000
XP7R18	MBP7	-	1.00000		
XP11R18	COST		5816.00000	MBR18	1.00000
XP11R18	MBP11		1.00000		
XP13R18	COST		4632.00000	MBR18	1.00000
XP13R18	MBP13	-	1.00000		
XP14R18	COST		10000.00000	MBR18	1.00000
XP14R18	MBP14	-	1.00000		
XP15R18	COST		3680.00000	MBR18	1.00000
XP15R18	MBP15	-	1.00000		
XP7R19	COST		6672.00000	MBR19	1.00000
XP7R19	MBP7	-	1.00000		
XP11R19	COST		6208.00000	MBR19	1.00000
XP11R19	MBP11		1.00000		
XP13R19	COST		5248.00000	MBR19	1.00000
XP13R19	MBP13	-	1.00000		
XP14R19	COST		10500.00000	MBR19	1.00000

XP14R19	MBP14	-1.00000		
XP15R19	COST	4179.00000	MBR19	1.00000
XP15R19	MBP15	-1.00000		
XP10P3	COST	3880.00000	MBP10	1.00000
XP10P3	MBP3	1.00000		
XP10P4	COST	3216.00000	MBP10	1.00000
XP10P4	MBP4	1.00000		
XP10P5	MBP5	1.00000	COST	2928.00000
XP10P5	MBP10	1.00000		
XP10P6	MBP6	1.00000	COST	2632.00000
XP10P6	MBP10	1.00000		
XP10P7	MBP7	1.00000	COST	2096.00000
XP10P7	MBP10	1.00000		
XP10P8	MBP8	1.00000	COST	1216.00000
XP10P8	MBP10	1.00000		
XP10P9	COST	3160.00000	MBP10	1.00000
XP10P9	MBP9	1.00000		
XP11P1	COST	4552.00000	MBP11	1.00000
XP11P1	MBP1	1.00000		
XP11P2	COST	4152.00000	MBP2	1.00000
XP11P2	MBP11	1.00000		
XP11P3	COST	4120.00000	MBP3	1.00000
XP11P3	MBP11	1.00000		
XP11P4	MBP4	1.00000	COST	3536.00000
XP11P4	MBP11	1.00000		
XP11P5	MBP5	1.00000	COST	3624.00000
XP11P5	MBP11	1.00000		
XP11P6	MBP6	1.00000	COST	3072.00000
XP11P6	MBP11	1.00000		
XP11P7	COST	2912.00000	MBP7	1.00000
XP11P7	MBP11	1.00000		
XP11P8	COST	2336.00000	MBP11	1.00000
XP11P8	MBP8	1.00000		
XP11P9	COST	3344.00000	MBP11	1.00000
XP11P9	MBP9	1.00000		
XP11P12	COST	3216.00000	MBP11	1.00000
XP11P12	MBP12	1.00000		
XS2P12	COST	5552.00000	MBS2	1.00000
XS2P12	MBP12	1.00000		
XS3P12	COST	3016.00000	MBS3	1.00000
XS3P12	MBP12	1.00000		
XP11P13	COST	3160.00000	MBP11	1.00000
XP11P13	MBP13	1.00000		
XS2P13	COST	2192.00000	MBS2	1.00000
XS2P13	MBP13	1.00000		
XS3P13	COST	2432.00000	MBS3	1.00000
XS3P13	MBP13	1.00000		
XP11P14	COST	4672.00000	MBP11	1.00000
XP11P14	MBP14	1.00000		
XP11P15	COST	6208.00000	MBP11	1.00000
XP11P15	MBP15	1.00000		
IP1	MBP1	1.00000	COST	3000.00000
IP1	TOTDEM	1.00000		
IP2	MBP2	1.00000	COST	3000.00000

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  IP2       TOTDEM          1.00000
  IP3       MBP3            1.00000   COST          3000.00000
  IP3       TOTDEM          1.00000
  IP4       MBP4            1.00000   COST          3000.00000
  IP4       TOTDEM          1.00000
  IP5       MBP5            1.00000   COST          3000.00000
  IP5       TOTDEM          1.00000
  IP6       MBP6            1.00000   COST          3000.00000
  IP6       TOTDEM          1.00000
  IP7       MBP7            1.00000   COST          3000.00000
  IP7       TOTDEM          1.00000
  IP8       MBP8            1.00000   COST          3000.00000
  IP8       TOTDEM          1.00000
  IP9       MBP9            1.00000   COST          3000.00000
  IP9       TOTDEM          1.00000
  IP10      MBP10     -     1.00000   COST          3000.00000
  IP10      TOTDEM          1.00000
  IP11      MBP11     -     1.00000   COST          3000.00000
  IP11      TOTDEM          1.00000
  IP12      MBP12           1.00000   COST          3000.00000
  IP12      TOTDEM          1.00000
  IP13      MBP13           1.00000   COST          3000.00000
  IP13      TOTDEM          1.00000
  IP14      MBP14           1.00000   COST          3000.00000
  IP14      TOTDEM          1.00000
  IP15      MBP15           1.00000   COST          3000.00000
  IP15      TOTDEM          1.00000
S
  RHS1      MBR1        10000.00000   MBR2          2000.00000
  RHS1      MBR3         5000.00000   MBR4         16000.00000
  RHS1      MBR5         5000.00000   MBR6         12000.00000
  RHS1      MBR7        28000.00000   MBR8         15000.00000
  RHS1      MBR9        22000.00000   MBR10         6000.00000
  RHS1      MBR11       15000.00000   MBR12        10000.00000
  RHS1      MBR13       10000.00000   MBR14         9000.00000
  RHS1      MBR15       20000.00000   MBR16        10000.00000
  RHS1      MBR17        7000.00000   MBR18        13000.00000
  RHS1      MBR19       25000.00000   MBP1        100000.0000
  RHS1      MBP2        28000.00000   MBP3         14000.00000
  RHS1      MBP4        60000.00000   MBP5         30000.00000
  RHS1      MBP6        15000.00000   MBP7        300000.0000
  RHS1      MBP8        35000.00000   MBP9         30000.00000
  RHS1      MBP10       30000.00000   MBP11       200000.0000
  RHS1      MBS2        10000.00000   MBS3         10000.00000
  RHS1      MBP12       15000.00000   MBP13        50000.00000
  RHS1      MBP14       45000.00000   MBP15        20000.00000
  RHS1      TOTDEM     732000.0000
INDS
  SHIPCAP   XP1R1       46800.00000
  SHIPCAP   XP2R1            .
  SHIPCAP   XP3R1            .
  SHIPCAP   XP7R1            .
  SHIPCAP   XP10R1           .
  SHIPCAP   XP11R1           .
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FX	SHIPCAP	XP1R2	.
FX	SHIPCAP	XP3R2	.
FX	SHIPCAP	XP4R2	.
FX	SHIPCAP	XP5R2	.
FX	SHIPCAP	XP6R2	.
FX	SHIPCAP	XP7R2	.
FX	SHIPCAP	XP10R2	.
UP	SHIPCAP	XP11R2	26560.00000
FX	SHIPCAP	XP1R3	.
UP	SHIPCAP	XP3R3	20400.00000
FX	SHIPCAP	XP4R3	.
FX	SHIPCAP	XP5R3	.
FX	SHIPCAP	XP6R3	.
UP	SHIPCAP	XP7R3	36496.00000
UP	SHIPCAP	XP10R3	30304.00000
FX	SHIPCAP	XP11R3	.
FX	SHIPCAP	XP1R4	.
FX	SHIPCAP	XP3R4	.
FX	SHIPCAP	XP4R4	.
FX	SHIPCAP	XP5R4	.
FX	SHIPCAP	XP6R4	.
FX	SHIPCAP	XP7R4	.
UP	SHIPCAP	XP10R4	18000.00000
FX	SHIPCAP	XP11R4	.
FX	SHIPCAP	XP1R5	.
UP	SHIPCAP	XP3R5	6000.00000
FX	SHIPCAP	XP4R5	.
FX	SHIPCAP	XP5R5	.
FX	SHIPCAP	XP6R5	.
FX	SHIPCAP	XP7R5	.
FX	SHIPCAP	XP10R5	.
FX	SHIPCAP	XP11R5	.
UP	SHIPCAP	XP2R6	12000.00000
FX	SHIPCAP	XP4R6	.
FX	SHIPCAP	XP5R6	.
FX	SHIPCAP	XP6R6	.
UP	SHIPCAP	XP7R6	36496.00000
FX	SHIPCAP	XP10R6	.
UP	SHIPCAP	XP11R6	132936.0000
FX	SHIPCAP	XP1R7	.
FX	SHIPCAP	XP3R7	.
UP	SHIPCAP	XP4R7	132936.0000
FX	SHIPCAP	XP5R7	.
FX	SHIPCAP	XP6R7	.
FX	SHIPCAP	XP7R7	.
FX	SHIPCAP	XP10R7	.
UP	SHIPCAP	XP11R7	9200.00000
FX	SHIPCAP	XP2R8	.
FX	SHIPCAP	XP4R8	.
FX	SHIPCAP	XP5R8	.
FX	SHIPCAP	XP6R8	.
FX	SHIPCAP	XP7R8	.
FX	SHIPCAP	XP10R8	.
UP	SHIPCAP	XP11R8	30485.00000

UP	SHIPCAP	XP7R9	29340.00000
FX	SHIPCAP	XP8R9	.
FX	SHIPCAP	XP9R9	.
UP	SHIPCAP	XP10R9	46832.00000
UP	SHIPCAP	XP11R9	28440.00000
FX	SHIPCAP	XP12R9	.
FX	SHIPCAP	XP13R9	.
FX	SHIPCAP	XS2R9	.
FX	SHIPCAP	XS3R9	.
FX	SHIPCAP	XP7R10	.
FX	SHIPCAP	XP8R10	.
FX	SHIPCAP	XP9R10	.
FX	SHIPCAP	XP10R10	.
UP	SHIPCAP	XP11R10	60480.00000
FX	SHIPCAP	XP12R10	.
FX	SHIPCAP	XP13R10	.
FX	SHIPCAP	XP14R10	.
FX	SHIPCAP	XS2R10	.
FX	SHIPCAP	XS3R10	.
FX	SHIPCAP	XP7R11	.
FX	SHIPCAP	XP8R11	.
FX	SHIPCAP	XP9R11	.
FX	SHIPCAP	XP10R11	.
UP	SHIPCAP	XP11R11	89712.00000
FX	SHIPCAP	XP12R11	.
FX	SHIPCAP	XP13R11	.
FX	SHIPCAP	XP14R11	.
FX	SHIPCAP	XS2R11	.
FX	SHIPCAP	XS3R11	.
UP	SHIPCAP	XP7R12	142467.0000
FX	SHIPCAP	XP8R12	.
FX	SHIPCAP	XP10R12	.
UP	SHIPCAP	XP11R12	149880.0000
FX	SHIPCAP	XP12R12	.
FX	SHIPCAP	XP13R12	.
FX	SHIPCAP	XP14R12	.
FX	SHIPCAP	XS2R12	.
FX	SHIPCAP	XS3R12	.
FX	SHIPCAP	XP7R13	.
FX	SHIPCAP	XP8R13	.
FX	SHIPCAP	XP10R13	.
FX	SHIPCAP	XP11R13	.
FX	SHIPCAP	XP12R13	.
UP	SHIPCAP	XP13R13	9152.00000
UP	SHIPCAP	XP14R13	37392.00000
FX	SHIPCAP	XS2R13	.
FX	SHIPCAP	XS3R13	.
FX	SHIPCAP	XP7R14	.
FX	SHIPCAP	XP8R14	.
FX	SHIPCAP	XP10R14	.
UP	SHIPCAP	XP11R14	37392.00000
FX	SHIPCAP	XP12R14	.
FX	SHIPCAP	XP13R14	.
FX	SHIPCAP	XP14R14	.

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
88	XP6R7	EQ	.	2776.00000	.	.	400.00000
89	XP7R7	EQ	.	3232.00000	.	.	944.00000
90	XP10R7	EQ	.	3536.00000	.	.	2320.00000-
91	XP11R7	UL	9200.00000	3656.00000	.	9200.00000	1752.00000-
92	XP2R8	EQ	.	3216.00000	.	.	3128.00000
93	XP4R8	EQ	.	3040.00000	.	.	2952.00000
94	XP5R8	EQ	.	6100.00000	.	.	6012.00000
95	XP6R8	EQ	.	6300.00000	.	.	6124.00000
96	XP7R8	EQ	.	1304.00000	.	.	1216.00000
97	XP10R8	EQ	.	2656.00000	.	.	1000.00000-
98	XP11R8	BS	15000.00000	3248.00000	.	30485.00000	.
99	XP7R9	LL	.	3264.00000	.	29340.00000	4144.00000
100	XP8R9	EQ	.	2960.00000	.	.	3840.00000
101	XP9R9	EQ	.	3400.00000	.	.	4280.00000
102	XP10R9	BS	9000.00000	2688.00000	.	46832.00000	.
103	XP11R9	BS	13000.00000	2280.00000	.	28440.00000	.
104	XP12R9	EQ	.	2624.00000	.	.	3504.00000
105	XP13R9	EQ	.	2840.00000	.	.	3720.00000
106	XS2R9	EQ	.	4750.00000	.	.	1506.00000
107	XS3R9	EQ	.	5000.00000	.	.	3240.00000
108	XP7R10	EQ	.	4552.00000	.	.	3776.00000
109	XP8R10	EQ	.	5000.00000	.	.	4224.00000
110	XP9R10	EQ	.	5000.00000	.	.	4224.00000
111	XP10R10	EQ	.	4368.00000	.	.	24.00000
112	XP11R10	BS	6000.00000	3936.00000	.	60480.00000	.
113	XP12R10	EQ	.	2888.00000	.	.	2112.00000
114	XP13R10	EQ	.	3408.00000	.	.	2632.00000
115	XP14R10	EQ	.	3784.00000	.	.	3008.00000
116	XS2R10	EQ	.	5000.00000	.	.	100.00000
117	XS3R10	EQ	.	5000.00000	.	.	1584.00000
118	XP7R11	EQ	.	4080.00000	.	.	3912.00000
119	XP8R11	EQ	.	3600.00000	.	.	3432.00000
120	XP9R11	EQ	.	3928.00000	.	.	3760.00000
121	XP10R11	EQ	.	3536.00000	.	.	200.00000-
122	XP11R11	BS	15000.00000	3328.00000	.	89712.00000	.
123	XP12R11	EQ	.	1080.00000	.	.	912.00000
124	XP13R11	EQ	.	2632.00000	.	.	2464.00000
125	XP14R11	EQ	.	3544.00000	.	.	3376.00000
126	XS2R11	EQ	.	5000.00000	.	.	708.00000
127	XS3R11	EQ	.	5250.00000	.	.	2442.00000
128	XP7R12	LL	.	3984.00000	.	142467.00000	3776.00000
129	XP8R12	EQ	.	6000.00000	.	.	5792.00000
130	XP10R12	EQ	.	3584.00000	.	.	192.00000-
131	XP11R12	BS	10000.00000	3368.00000	.	145880.00000	.
132	XP12R12	EQ	.	1800.00000	.	.	1592.00000
133	XP13R12	EQ	.	2600.00000	.	.	2392.00000
134	XP14R12	EQ	.	3064.00000	.	.	2856.00000
135	XS2R12	EQ	.	4600.00000	.	.	268.00000
136	XS3R12	EQ	.	3120.00000	.	.	272.00000
137	XP7R13	EQ	.	5360.00000	.	.	2736.00000
138	XP8R13	EQ	.	7500.00000	.	.	4876.00000

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
139	XP10R13	EQ	.	7250.00000	.	.	1058.00000
140	XP11R13	EQ	.	4552.00000	.	.	1232.00000-
141	XP12R13	EQ	.	7500.00000	.	.	4876.00000
142	XP13R13	LL	.	4500.00000	.	9152.00000	1876.00000
143	XP14R13	BS	10000.00000	2624.00000	.	37392.00000	.
144	XS2R13	EQ	.	7000.00000	.	.	252.00000
145	XS3R13	EQ	.	7100.00000	.	.	1836.00000
146	XP7R14	EQ	.	4456.00000	.	.	3864.00000
147	XP8R14	EQ	.	6200.00000	.	.	5608.00000
148	XP10R14	EQ	.	6100.00000	.	.	1940.00000
149	XP11R14	BS	9000.00000	3752.00000	.	37392.00000	.
150	XP12R14	EQ	.	6000.00000	.	.	5408.00000
151	XP13R14	EQ	.	2736.00000	.	.	2144.00000
152	XP14R14	EQ	.	5000.00000	.	.	4408.00000
153	XP15R14	EQ	.	5500.00000	.	.	4908.00000
154	XS2R14	EQ	.	5750.00000	.	.	1034.00000
155	XS3R14	EQ	.	5500.00000	.	.	2268.00000
156	XP7R15	EQ	.	4320.00000	.	.	3944.00000
157	XP11R15	BS	.	3536.00000	.	96668.00000	.
158	XP13R15	EQ	.	3112.00000	.	.	2736.00000
159	XS2R15	BS	10000.00000	4500.00000	.	82368.00000	.
160	XS3R15	BS	10000.00000	3016.00000	.	69368.00000	.
161	XP7R16	EQ	.	5136.00000	.	.	3856.00000
162	XP11R16	BS	10000.00000	4440.00000	.	68896.00000	.
163	XP13R16	EQ	.	3640.00000	.	.	2360.00000
164	XP14R16	EQ	.	2248.00000	.	.	968.00000
165	XP15R16	EQ	.	2576.00000	.	.	1296.00000
166	XP7R17	EQ	.	5528.00000	.	.	1544.00000
167	XP11R17	EQ	.	4906.00000	.	.	2238.00000-
168	XP12R17	EQ	.	8000.00000	.	.	4016.00000
169	XP13R17	BS	7000.00000	3984.00000	.	43808.00000	.
170	XP14R17	EQ	.	3112.00000	.	.	872.00000-
171	XP15R17	EQ	.	2680.00000	.	.	1304.00000-
172	XP7R18	EQ	.	15000.00000	.	.	11320.00000
173	XP11R18	EQ	.	5816.00000	.	.	1024.00000-
174	XP13R18	EQ	.	4632.00000	.	.	952.00000
175	XP14R18	EQ	.	10000.00000	.	.	6320.00000
176	XP15R18	BS	13000.00000	3680.00000	.	42000.00000	.
177	XP7R19	EQ	.	6672.00000	.	.	3624.00000
178	XP11R19	BS	25000.00000	6208.00000	.	137984.00000	.
179	XP13R19	EQ	.	5248.00000	.	.	2200.00000
180	XP14R19	EQ	.	10500.00000	.	.	7452.00000
181	XP15R19	EQ	.	4179.00000	.	.	1131.00000
182	XP10P3	EQ	.	3880.00000	.	.	312.00000
183	XP10P4	EQ	.	3216.00000	.	.	352.00000-
184	XP10P5	EQ	.	2928.00000	.	.	640.00000-
185	XP10P6	EQ	.	2632.00000	.	.	848.00000-
186	XP10P7	EQ	.	2096.00000	.	.	1472.00000-
187	XP10P8	EQ	.	1216.00000	.	.	2352.00000-
188	XP10P9	EQ	.	3160.00000	.	.	408.00000-
189	XP11P1	LL	.	4552.00000	.	201584.00000	1392.00000

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
190	XP11P2	LL	.	4152.00000	.	132936.00000	992.00000
191	XP11P3	EQ	.	4120.00000	.	.	960.00000
192	XP11P4	LL	.	3536.00000	.	136688.00000	376.00000
193	XP11P5	EQ	.	3624.00000	.	.	464.00000
194	XP11P6	BS	15000.00000	3072.00000	.	15680.00000	.
195	XP11P7	UL	43808.00000	2912.00000	.	43808.00000	248.00000-
196	XP11P8	UL	12464.00000	2336.00000	.	12464.00000	824.00000-
197	XP11P9	LL	.	3344.00000	.	17360.00000	184.00000
198	XP11P12	LL	.	3216.00000	.	108580.00000	56.00000
199	XS2P12	EQ	.	5552.00000	.	.	1428.00000
200	XS3P12	EQ	.	3016.00000	.	.	376.00000
201	XP11P13	BS	2528.00000	3160.00000	.	260353.00000	.
202	XS2P13	EQ	.	2192.00000	.	.	1932.00000-
203	XS3P13	EQ	.	2432.00000	.	.	208.00000-
204	XP11P14	LL	.	4672.00000	.	73792.00000	1512.00000
205	XP11P15	EQ	.	6208.00000	.	.	3048.00000
206	IP1	BS	110000.00000	3000.00000	.	NONE	.
207	IP2	BS	28000.00000	3000.00000	.	NONE	.
208	IP3	BS	19000.00000	3000.00000	.	NONE	.
209	IP4	BS	78800.00000	3000.00000	.	NONE	.
210	IP5	BS	30000.00000	3000.00000	.	NONE	.
211	IP6	LL	.	3000.00000	.	NONE	88.00000
212	IP7	BS	256192.00000	3000.00000	.	NONE	.
213	IP8	BS	22536.00000	3000.00000	.	NONE	.
214	IP9	BS	30000.00000	3000.00000	.	NONE	.
215	IP10	LL	.	3000.00000	.	NONE	3568.00000
216	IP11	LL	.	3000.00000	.	NONE	3160.00000
217	IP12	BS	15000.00000	3000.00000	.	NONE	.
218	IP13	BS	54472.00000	3000.00000	.	NONE	.
219	IP14	BS	55000.00000	3000.00000	.	NONE	.
220	IP15	BS	33000.00000	3000.00000	.	NONE	.

RANGE

TIME = 0.24 MINS. ITERATION NUMBER = 60

...NAME...	...ACTIVITY...	DEFINED AS
FUNCTIONAL	3259970816.00	COST
RESTRAINTS		RHS1
BCUNDS....		SHIPCAP

SECTION 1 - ROWS AT LIMIT LEVEL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
2	MBR1	EQ	10000.00000	.	10000.00000 10000.00000	7472.00000 10000.00000	6379.99609- 6379.99609		XP11P13 MBS2	LL UL
3	MBR2	EQ	2000.00000	.	2000.00000 2000.00000	. 2000.00000	5155.99609- 5155.99609		XP11R2 MBS2	LL UL
4	MBR3	EQ	5000.00000	.	5000.00000 5000.00000	. 5000.00000	4571.99609- 4571.99609		XP1CR3 MBS2	LL UL
5	MBR4	EQ	16000.00000	.	16000.00000 16000.00000	6000.00391 16000.00000	3963.99976- 3963.99976		XS2R15 MBS2	LL UL
6	MBR5	EQ	5000.00000	.	5000.00000 5000.00000	2472.00000 5000.00000	5483.99609- 5483.99609		XP11P13 MBS2	LL UL
7	MBR6	EQ	12000.00000	.	12000.00000 12000.00000	2000.00391 12000.00000	4595.99609- 4595.99609		XS2R15 MBS2	LL UL
8	MBR7	EQ	28000.00000	.	28000.00000 28000.00000	25472.00000 28000.00000	6411.99609- 6411.99609		XP11P13 MBS2	LL UL
9	MBR8	EQ	15000.00000	.	15000.00000 15000.00000	5000.00391 15000.00000	4211.99609- 4211.99609		XS2R15 MBS2	LL UL
10	MBR9	EQ	22000.00000	.	22000.00000 22000.00000	12000.00391 22000.00000	3243.99976- 3243.99976		XS2R15 MBS2	LL UL
11	MBR10	EQ	6000.00000	.	6000.00000 6000.00000	. 6000.00000	4899.99609- 4899.99609		XP11R10 MBS2	LL UL
12	MBR11	EQ	15000.00000	.	15000.00000 15000.00000	5000.00391 15000.00000	4291.99609- 4291.99609		XS2R15 MBS2	LL UL
13	MBR12	EQ	10000.00000	.	10000.00000 10000.00000	. 10000.00000	4331.99609- 4331.99609		XS2R15 MBS2	LL UL
14	MBR13	EQ	10000.00000	.	10000.00000 10000.00000	7472.00000 10000.00000	6747.99609- 6747.99609		XP11P13 MBS2	LL UL
15	MBR14	EQ	9000.00000	.	9000.00000 9000.00000	. 9000.00000	4715.99609- 4715.99609		XP11R14 MBS2	LL UL
16	MBR15	EQ	20000.00000	.	20000.00000 20000.00000	10000.00391 20000.00000	4499.99609- 4499.99609		XS2R15 MBS2	LL UL
17	MBR16	EQ	10000.00000	.	10000.00000 10000.00000	. 10000.00000	5403.99609- 5403.99609		XS2R15 MBS2	LL UL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
18	MBR17	EQ	7000.00000	.	7000.00000 7000.00000	4472.00000 7000.00000	8107.99609- 8107.99609		XF11P13 MBS2	LL UL
19	MBR18	EQ	13000.00000	.	13000.00000 13000.00000	10472.00000 13000.00000	7803.99609- 7803.99609		XF11P13 MBS2	LL UL
20	MBR19	EQ	25000.00000	.	25000.00000 25000.00000	15000.00391 25000.00000	7171.99609- 7171.99609		XS2R15 MBS2	LL UL
21	MBP1	EQ	100000.00000	.	100000.00000 100000.00000	97472.00000 100000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
22	MBP2	EQ	28000.00000	.	28000.00000 28000.00000	25472.00000 28000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
23	MBP3	EQ	14000.00000	.	14000.00000 14000.00000	11472.00000 14000.00000	4123.99609- 4123.99609		XF11P13 MBS2	LL UL
24	MBP4	EQ	60000.00000	.	60000.00000 60000.00000	57472.00000 60000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
25	MBP5	EQ	30000.00000	.	30000.00000 30000.00000	27472.00000 30000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
26	MBP6	EQ	15000.00000	.	15000.00000 15000.00000	5000.00391 15000.00000	4035.99976- 4035.99976		XS2R15 MBS2	LL UL
27	MBP7	EQ	300000.00000	.	300000.00000 300000.00000	297472.00000 300000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
28	MBP8	EQ	35000.00000	.	35000.00000 35000.00000	32472.00000 35000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
29	MBP9	EQ	30000.00000	.	30000.00000 30000.00000	27472.00000 30000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
30	MBP10	UL	30000.00000	.	NONE 30000.00000	30000.00000 39999.99609	555.99976 555.99976-		MBS2 XS2R15	UL LL
31	MBP11	UL	200000.00000	.	NONE 200000.00000	200000.00000 209999.99609	963.99976 963.99976-		MBS2 XS2R15	UL LL
32	MBP12	EQ	15000.00000	.	15000.00000 15000.00000	12472.00000 15000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
33	MBP13	EQ	50000.00000	.	50000.00000 50000.00000	47472.00000 50000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
34	MBP14	EQ	45000.00000	.	45000.00000 45000.00000	42472.00000 45000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
35	MBP15	EQ	20000.00000	.	20000.00000 20000.00000	17472.00000 20000.00000	4123.99609- 4123.99609		XP11P13 MBS2	LL UL
37	MBS3	UL	10000.00000	.	NONE 10000.00000	10000.00000 19999.99609	1483.99976 1483.99976-		MBS2 XS2R15	UL LL
38	TOTDEM	EQ	732000.00000	.	732000.00000 732000.00000	732000.00000 734528.00000	1123.99976 1123.99976-		MBS2 XP11P13	UL LL

SECTION 2 - COLUMNS AT LIMIT LEVEL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
40	XP2R1	EQ	.	3528.00000	. .	27999.99609- 9999.99609	1272.00000- 1272.00000	INFINITY 2256.00000	IP2 XP1R1	LL LL
41	XP3R1	EQ	.	4500.00000	. .	18999.99609- 9999.99609	2244.00000- 2244.00000	INFINITY 2256.00000	IP3 XP1R1	LL LL
42	XP7R1	EQ	.	4344.00000	. .	36800.00000- 9999.99609	2088.00000- 2088.00000	INFINITY 2256.00000	XP1R1 XP1R1	UL LL
43	XP10R1	EQ	.	4648.00000	. .	12999.99609- 2528.00000	1175.99976 1175.99976-	5823.99976 INFINITY-	XP11R9 XP11P13	LL LL
44	XP11R1	EQ	.	4920.00000	. .	36800.00000- 2528.00000	495.99976 495.99976-	5415.99976 INFINITY-	XP1R1 XP11P13	UL LL
45	XP1R2	EQ	.	2320.00000	. .	2528.00000- 1999.99976	1288.00000- 1288.00000	INFINITY 1032.00000	XP11P13 XP11R2	LL LL
46	XP3R2	EQ	.	1088.00000	. .	2528.00000- 1999.99976	56.00000- 56.00000	INFINITY 1032.00000	XP11P13 XP11R2	LL LL
47	XP4R2	EQ	.	2480.00000	. .	2528.00000- 1999.99976	1448.00000- 1448.00000	INFINITY 1032.00000	XP11P13 XP11R2	LL LL
48	XP5R2	EQ	.	3000.00000	. .	2528.00000- 1999.99976	1968.00000- 1968.00000	INFINITY 1032.00000	XP11P13 XP11R2	LL LL
49	XP6R2	EQ	.	3500.00000	. .	15000.00000- 679.99951	2379.99976- 2379.99976	INFINITY 1120.00024	XP11P6 XP11P6	LL UL
50	XP7R2	EQ	.	3608.00000	. .	2528.00000- 1999.99976	2576.00000- 2576.00000	INFINITY 1032.00000	XP11P13 XP11R2	LL LL
51	XP10R2	EQ	.	3912.00000	. .	12999.99609- 1999.99976	687.99976 687.99976-	4599.99976 INFINITY-	XP11R9 XP11R2	LL LL
53	XP1R3	EQ	.	2880.00000	. .	2528.00000- 5000.00000	2431.99976- 2431.99976	INFINITY 448.00024	XP11P13 XP10R3	LL LL
54	XP3R3	LL	.	1487.99948	. 20399.99941	2527.99943- 4999.99992	1039.99939- 1039.99939	INFINITY 448.00009	XP11P13 XP10R3	LL LL
55	XP4R3	EQ	.	3272.00000	. .	2528.00000- 4999.99609	2823.99976- 2823.99976	INFINITY 448.00024	XP11P13 XP10R3	LL LL
56	XP5R3	EQ	.	6500.00000	. .	2528.00000- 4999.99609	6051.99609- 6051.99609	INFINITY 448.00391	XP11P13 XP10R3	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. / ..UPPER LIMIT.	LOWER ACTIVITY / UPPER ACTIVITY	...UNIT COST.. / ...UNIT COST..	..UPPER COST.. / ..LOWER COST..	LIMITING PROCESS.	AT / AT
57	XP6R3	EQ	.	6750.00000	.	8999.99609-	6213.99609-	INFINITY	XP10R5	LL
					.	679.99951	6213.99609	536.00391	XP11P6	UL
58	XP7R3	LL	.	3695.99995	.	2527.99890-	3247.99968-	INFINITY	XP11P13	LL
					36495.99953	4999.99891	3247.99968	448.00027	XP10R3	LL
60	XP11R3	EQ	.	4560.00000	.	8999.99609-	951.99976-	INFINITY	XP10R9	LL
					.	4999.99609	951.99976	3608.00024	XP10R3	LL
61	XP1R4	EQ	.	2944.00000	.	2000.00024-	3103.99976-	INFINITY	XP10R4	UL
					.	12999.99609	3103.99976	159.99976-	XP11R5	LL
62	XP3R4	EQ	.	2048.00000	.	2000.00024-	2207.99976-	INFINITY	XP10R4	UL
					.	12999.99609	2207.99976	159.99976-	XP11R5	LL
63	XP4R4	EQ	.	2224.00000	.	2000.00024-	2383.99976-	INFINITY	XP10R4	UL
					.	12999.99609	2383.99976	159.99976-	XP11R9	LL
64	XP5R4	EQ	.	2008.00000	.	2000.00024-	2167.99976-	INFINITY	XP10R4	UL
					.	12999.99609	2167.99976	159.99976-	XP11R5	LL
65	XP6R4	EQ	.	2528.00000	.	2000.00024-	2599.99976-	INFINITY	XP10R4	UL
					.	679.99951	2599.99976	71.99976-	XP11P6	UL
66	XP7R4	EQ	.	3112.00000	.	2000.00024-	3271.99976-	INFINITY	XP10R4	UL
					.	12999.99609	3271.99976	159.99976-	XP11R5	LL
68	XP11R4	EQ	.	3576.00000	.	2000.00024-	575.99976-	INFINITY	XP10R4	UL
					.	12999.99609	575.99976	3000.00024	XP11R9	LL
69	XP1R5	EQ	.	2336.00000	.	999.99976-	975.99976-	INFINITY	XP3R5	UL
					.	5000.00000	975.99976	1360.00024	XP3R5	LL
71	XP4R5	EQ	.	2944.00000	.	999.99976-	1583.99976-	INFINITY	XP3R5	UL
					.	5000.00000	1583.99976	1360.00024	XP3R5	LL
72	XP5R5	EQ	.	6000.00000	.	999.99976-	4639.99609-	INFINITY	XP3R5	UL
					.	5000.00000	4639.99609	1360.00391	XP3R5	LL
73	XP6R5	EQ	.	6250.00000	.	999.99976-	4801.99609-	INFINITY	XP3R5	UL
					.	679.99951	4801.99609	1448.00391	XP11P6	UL
74	XP7R5	EQ	.	3416.00000	.	999.99976-	2055.99976-	INFINITY	XP3R5	UL
					.	5000.00000	2055.99976	1360.00024	XP3R5	LL
75	XP10R5	EQ	.	3720.00000	.	999.99976-	1208.00000	4928.00000	XP3R5	UL
					.	2528.00000	1208.00000-	INFINITY-	XP11P13	LL
76	XP11R5	EQ	.	3944.00000	.	999.99976-	576.00000	4520.00000	XP3R5	UL
					.	2528.00000	576.00000-	INFINITY-	XP11P13	LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. / ..UPPER LIMIT.	LOWER ACTIVITY / UPPER ACTIVITY	...UNIT COST.. / ...UNIT COST..	..UPPER COST.. / ..LOWER COST..	LIMITING / PROCESS.	AT / AT
77	XP2R6	LL	.	1991.99869	.	2527.99950-	1519.99908-	INFINITY	XP11P13	LL
					11999.99965	11999.99081	1519.99908	471.99961	XP11R6	LL
78	XP4R6	EQ	.	3368.00000	.	2528.00000-	2896.00000-	INFINITY	XP11P13	LL
					.	11999.99219	2896.00000	472.00000	XP11R6	LL
79	XP5R6	EQ	.	2200.00000	.	2528.00000-	1728.00000-	INFINITY	XP11P13	LL
					.	11999.99219	1728.00000	472.00000	XP11R6	LL
80	XP6R6	EQ	.	2776.00000	.	15000.00000-	2216.00000-	INFINITY	XP11P6	LL
					.	679.99951	2216.00000	560.00000	XP11P6	UL
81	XP7R6	LL	.	2823.99975	.	2527.99890-	2351.99960-	INFINITY	XP11P13	LL
					36495.99953	11999.99319	2351.99960	472.00015	XP11R6	LL
82	XP10R6	EQ	.	3312.00000	.	12999.99609-	727.99976	4039.99976	XP11R9	LL
					.	8999.99609	727.99976-	INFINITY-	XP10R9	LL
84	XP1R7	EQ	.	4224.00000	.	109999.93750-	1935.99976-	INFINITY	IP1	LL
					.	18800.00000	1935.99976	2288.00024	XP4R7	LL
85	XP3R7	EQ	.	4500.00000	.	18999.99609-	2211.99976-	INFINITY	IP3	LL
					.	18800.00000	2211.99976	2288.00024	XP4R7	LL
87	XP5R7	EQ	.	2376.00000	.	29999.99609-	87.99998-	INFINITY	IP5	LL
					.	18800.00000	87.99998	2288.00002	XP4R7	LL
88	XP6R7	EQ	.	2776.00000	.	15000.00000-	399.99976-	INFINITY	XP11P6	LL
					.	679.99951	399.99976	2376.00024	XP11P6	UL
89	XP7R7	EQ	.	3232.00000	.	114135.93750-	943.99976-	INFINITY	XP4R7	UL
					.	18800.00000	943.99976	2288.00024	XP4R7	LL
90	XP10R7	EQ	.	3536.00000	.	12999.99609-	2320.00000	5856.00000	XP11R9	LL
					.	2528.00000	2320.00000-	INFINITY-	XP11P13	LL
91	XP11R7	UL	9199.99026	3695.99970	.	45271.98687-	1752.00051	5448.00021	IP13	LL
					9199.99704	11727.98941	1752.00051-	INFINITY-	XP11P13	LL
92	XP2R8	EQ	.	3216.00000	.	2528.00000-	3127.99976-	INFINITY	XP11P13	LL
					.	15000.00000	3127.99976	88.00024	XP11R8	LL
93	XP4R8	EQ	.	3040.00000	.	2528.00000-	2951.99976-	INFINITY	XP11P13	LL
					.	15000.00000	2951.99976	88.00024	XP11R8	LL
94	XP5R8	EQ	.	6100.00000	.	2528.00000-	6011.99609-	INFINITY	XP11P13	LL
					.	15000.00000	6011.99609	88.00391	XP11R8	LL
95	XP6R8	EQ	.	6300.00000	.	15000.00000-	6123.99609-	INFINITY	XP11P6	LL
					.	679.99951	6123.99609	176.00391	XP11P6	UL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
96	XP7R8	EQ	.	1304.00000	. .	2528.00000- 15000.00000	1215.99976- 1215.99976	INFINITY 88.00024	XP11P13 XP11R8	LL LL
97	XP10R8	EQ	.	2656.00000	. .	12999.99609- 8999.99609	1000.00000 1000.00000-	3656.00000 INFINITY-	XP11R9 XP10R9	LL LL
99	XP7R9	LL	.	3263.99999	. 29339.99692	2527.99978- 12999.99575	4144.00003- 4144.00003	INFINITY 880.00004-	XP11P13 XP11R9	LL LL
100	XP8R9	EQ	.	2960.00000	. .	2528.00000- 12999.99609	3839.99976- 3839.99976	INFINITY 879.99976-	XP11P13 XP11R9	LL LL
101	XP9R9	EQ	.	3400.00000	. .	2528.00000- 12999.99609	4279.99609- 4279.99609	INFINITY 879.99609-	XP11P13 XP11R9	LL LL
104	XP12R9	EQ	.	2624.00000	. .	2528.00000- 12999.99609	3503.99976- 3503.99976	INFINITY 879.99976-	XP11P13 XP11R9	LL LL
105	XP13R9	EQ	.	2840.00000	. .	2528.00000- 12999.99609	3719.99976- 3719.99976	INFINITY 879.99976-	XP11P13 XP11R9	LL LL
106	XS2R9	EQ	.	4750.00000	. .	. 9999.99609	1506.00000- 1506.00000	INFINITY 3244.00000	XP11R15 XS2R15	LL LL
107	XS3R9	EQ	.	5000.00000	. .	. 9999.99609	3239.99976- 3239.99976	INFINITY 1760.00024	XP11R15 XS3R15	LL LL
108	XP7R10	EQ	.	4552.00000	. .	2528.00000- 6000.00000	3776.00000- 3776.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
109	XP8R10	EQ	.	5000.00000	. .	2528.00000- 6000.00000	4224.00000- 4224.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
110	XP9R10	EQ	.	5000.00000	. .	2528.00000- 6000.00000	4224.00000- 4224.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
111	XP10R10	EQ	.	4368.00000	. .	12999.99609- 6000.00000	24.00000- 24.00000	INFINITY 4344.00000	XP11R9 XP11R10	LL LL
113	XP12R10	EQ	.	2888.00000	. .	2528.00000- 6000.00000	2112.00000- 2112.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
114	XP13R10	EQ	.	3408.00000	. .	2528.00000- 6000.00000	2632.00000- 2632.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
115	XP14R10	EQ	.	3784.00000	. .	2528.00000- 6000.00000	3008.00000- 3008.00000	INFINITY 776.00000	XP11P13 XP11R10	LL LL
116	XS2R10	EQ	.	5000.00000	. .	. 6000.00000	100.00000- 100.00000	INFINITY 4900.00000	XP11R15 XP11R10	LL LL

NUMBER	COLUMN	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
117	XS3R10	EQ	.	5000.00000	. .	. 6000.00000	1583.99976- 1583.99976	INFINITY 3416.00024	XP11R15 XP11R10	LL LL
118	XP7R11	EQ	.	4080.00000	. .	2528.00000- 15000.00000	3912.00000- 3912.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
119	XP8R11	EQ	.	3600.00000	. .	2528.00000- 15000.00000	3432.00000- 3432.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
120	XP9R11	EQ	.	3928.00000	. .	2528.00000- 15000.00000	3760.00000- 3760.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
121	XP10R11	EQ	.	3536.00000	. .	12999.99609- 8999.99609	199.99998 199.99998-	3735.99998 INFINITY-	XP11R9 XP10R9	LL LL
123	XP12R11	EQ	.	1080.00000	. .	2528.00000- 15000.00000	912.00000- 912.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
124	XP13R11	EQ	.	2632.00000	. .	2528.00000- 15000.00000	2464.00000- 2464.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
125	XP14R11	EQ	.	3544.00000	. .	2528.00000- 15000.00000	3376.00000- 3376.00000	INFINITY 168.00000	XP11P13 XP11R11	LL LL
126	XS2R11	EQ	.	5000.00000	. .	. 9999.99609	708.00000- 708.00000	INFINITY 4292.00000	XP11R15 XS2R15	LL LL
127	XS3R11	EQ	.	5250.00000	. .	. 9999.99609	2441.99976- 2441.99976	INFINITY 2808.00024	XP11R15 XS3R15	LL LL
128	XP7R12	LL	.	3983.99956	. 142466.97371	2527.99952- 9999.99601	3775.99980- 3775.99980	INFINITY 207.99976	XP11P13 XP11R12	LL LL
129	XP8R12	EQ	.	6000.00000	. .	2528.00000- 9999.99609	5791.99609- 5791.99609	INFINITY 208.00391	XP11P13 XP11R12	LL LL
130	XP10R12	EQ	.	3584.00000	. .	12999.99609- 8999.99609	192.00000 192.00000-	3776.00000 INFINITY-	XP11R9 XP10R9	LL LL
132	XP12R12	EQ	.	1800.00000	. .	2528.00000- 9999.99609	1591.99976- 1591.99976	INFINITY 208.00024	XP11P13 XP11R12	LL LL
133	XP13R12	EQ	.	2600.00000	. .	2528.00000- 9999.99609	2391.99976- 2391.99976	INFINITY 208.00024	XP11P13 XP11R12	LL LL
134	XP14R12	EQ	.	3064.00000	. .	2528.00000- 9999.99609	2855.99976- 2855.99976	INFINITY 208.00024	XP11P13 XP11R12	LL LL
135	XS2R12	EQ	.	4600.00000	. .	. 9999.99609	268.00000- 268.00000	INFINITY 4332.00000	XP11R15 XP11R12	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. / ..UPPER LIMIT.	LOWER ACTIVITY / UPPER ACTIVITY	...UNIT COST.. / ...UNIT COST..	..UPPER COST.. / ..LOWER COST..	LIMITING PROCESS.	AT / AT
136	XS3R12	EQ	.	3120.00000	.	.	271.99976-	INFINITY	XP11R15	LL
					.	9999.99609	271.99976	2848.00024	XS3R15	LL
137	XP7R13	EQ	.	5360.00000	.	27391.99609-	2735.99976-	INFINITY	XP14R13	UL
					.	10000.00000	2735.99976	2624.00024	XP14R13	LL
138	XP8R13	EQ	.	7500.00000	.	22536.00000-	4875.99609-	INFINITY	IP8	LL
					.	10000.00000	4875.99609	2624.00391	XP14R13	LL
139	XP10R13	EQ	.	7250.00000	.	12999.99609-	1057.99976-	INFINITY	XP11R9	LL
					.	2528.00000	1057.99976	6192.00024	XP11P13	LL
140	XP11R13	EQ	.	4552.00000	.	27391.99609-	1232.00000	5784.00000	XP14R13	UL
					.	2528.00000	1232.00000-	INFINITY-	XP11P13	LL
141	XP12R13	EQ	.	7500.00000	.	14999.99609-	4875.99609-	INFINITY	IP12	LL
					.	10000.00000	4875.99609	2624.00391	XP14R13	LL
142	XP13R13	LL	.	4500.00057	.	27391.98243-	1876.00079-	INFINITY	XP14R13	UL
					9151.99607	9999.99585	1876.00079	2623.99977	XP14R13	LL
144	XS2R13	EQ	.	7000.00000	.	.	252.00000-	INFINITY	XP11R15	LL
					.	2528.00000	252.00000	6748.00000	XP11P13	LL
145	XS3R13	EQ	.	7100.00000	.	.	1835.99976-	INFINITY	XP11R15	LL
					.	2528.00000	1835.99976	5264.00024	XP11P13	LL
146	XP7R14	EQ	.	4456.00000	.	2528.00000-	3863.99976-	INFINITY	XP11P13	LL
					.	8999.99609	3863.99976	592.00024	XP11R14	LL
147	XP8R14	EQ	.	6200.00000	.	2528.00000-	5607.99609-	INFINITY	XP11P13	LL
					.	8999.99609	5607.99609	592.00391	XP11R14	LL
148	XP10R14	EQ	.	6100.00000	.	12999.99609-	1939.99976-	INFINITY	XP11R9	LL
					.	8999.99609	1939.99976	4160.00024	XP10R9	LL
150	XP12R14	EQ	.	6000.00000	.	2528.00000-	5407.99609-	INFINITY	XP11P13	LL
					.	8999.99609	5407.99609	592.00391	XP11R14	LL
151	XP13R14	EQ	.	2736.00000	.	2528.00000-	2143.99976-	INFINITY	XP11P13	LL
					.	8999.99609	2143.99976	592.00024	XP11R14	LL
152	XP14R14	EQ	.	5000.00000	.	2528.00000-	4407.99609-	INFINITY	XP11P13	LL
					.	8999.99609	4407.99609	592.00391	XP11R14	LL
153	XP15R14	EQ	.	5500.00000	.	2528.00000-	4907.99609-	INFINITY	XP11P13	LL
					.	8999.99609	4907.99609	592.00391	XP11R14	LL
154	XS2R14	EQ	.	5750.00000	.	.	1034.00000-	INFINITY	XP11R15	LL
					.	8999.99609	1034.00000	4716.00000	XP11R14	LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	...INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
155	XS3R14	EQ	.	5500.00000	. .	. 8999.99609	2267.99976- 2267.99976	INFINITY 3232.00024	XP11R15 XP11R14	LL LL
156	XP7R15	EQ	.	4320.00000	. .	2528.00000- .	3944.00000- 3944.00000	INFINITY 376.00000	XP11P13 XP11R15	LL LL
158	XP13R15	EQ	.	3112.00000	. .	2528.00000- .	2736.00000- 2736.00000	INFINITY 376.00000	XP11P13 XP11R15	LL LL
161	XP7R16	EQ	.	5136.00000	. .	2528.00000- 9999.99609	3855.99976- 3855.99976	INFINITY 1280.00024	XP11P13 XP11R16	LL LL
163	XP13R16	EQ	.	3640.00000	. .	2528.00000- 9999.99609	2359.99976- 2359.99976	INFINITY 1280.00024	XP11P13 XP11R16	LL LL
164	XP14R16	EQ	.	2248.00000	. .	2528.00000- 9999.99609	967.99976- 967.99976	INFINITY 1280.00024	XP11P13 XP11R16	LL LL
165	XP15R16	EQ	.	2576.00000	. .	2528.00000- 9999.99609	1295.99976- 1295.99976	INFINITY 1280.00024	XP11P13 XP11R16	LL LL
166	XP7R17	EQ	.	5528.00000	. .	36807.99609- 7000.00000	1544.00000- 1544.00000	INFINITY 3984.00000	XP13R17 XP13R17	UL LL
167	XP11R17	EQ	.	4906.00000	. .	36807.99609- 2528.00000	2237.99976 2237.99976-	7143.99976 INFINITY-	XP13R17 XP11P13	UL LL
168	XP12R17	EQ	.	8000.00000	. .	14999.99609- 7000.00000	4016.00000- 4016.00000	INFINITY 3984.00000	IP12 XP13R17	LL LL
170	XP14R17	EQ	.	3112.00000	. .	36807.99609- 7000.00000	871.99976 871.99976-	3983.99976 INFINITY-	XP13R17 XP13R17	UL LL
171	XP15R17	EQ	.	2680.00000	. .	32999.99609- 7000.00000	1303.99976 1303.99976-	3983.99976 INFINITY-	IP15 XP13R17	LL LL
172	XP7R18	EQ	.	15000.00000	. .	28999.99609- 13000.00000	11319.99609- 11319.99609	INFINITY 3680.00391	XP15R18 XP15R18	UL LL
173	XP11R18	EQ	.	5816.00000	. .	28999.99609- 2528.00000	1023.99976 1023.99976-	6839.99976 INFINITY-	XP15R18 XP11P13	UL LL
174	XP13R18	EQ	.	4632.00000	. .	28999.99609- 13000.00000	951.99976- 951.99976	INFINITY 3680.00024	XP15R18 XP15R18	UL LL
175	XP14R18	EQ	.	10000.00000	. .	28999.99609- 13000.00000	6319.99609- 6319.99609	INFINITY 3680.00391	XP15R18 XP15R18	UL LL
177	XP7R19	EQ	.	6672.00000	. .	2528.00000- 25000.00000	3623.99976- 3623.99976	INFINITY 3048.00024	XP11P13 XP11R19	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
179	XP13R19	EQ	.	5248.00000	. .	2528.00000- 25000.00000	2199.99976- 2199.99976	INFINITY 3048.00024	XP11P13 XP11R19	LL LL
180	XP14R19	EQ	.	10500.00000	. .	2528.00000- 25000.00000	7451.99609- 7451.99609	INFINITY 3048.00391	XP11P13 XP11R19	LL LL
181	XP15R19	EQ	.	4179.00000	. .	2528.00000- 25000.00000	1130.99976- 1130.99976	INFINITY 3048.00024	XP11P13 XP11R19	LL LL
182	XP10P3	EQ	.	3880.00000	. .	12999.99609- 2528.00000	312.00000- 312.00000	INFINITY 3568.00000	XP11R9 XP11P13	LL LL
183	XP10P4	EQ	.	3216.00000	. .	12999.99609- 2528.00000	351.99976 351.99976-	3567.99976 INFINITY-	XP11R9 XP11P13	LL LL
184	XP10P5	EQ	.	2928.00000	. .	12999.99609- 2528.00000	639.99976 639.99976-	3567.99976 INFINITY-	XP11R9 XP11P13	LL LL
185	XP10P6	EQ	.	2632.00000	. .	679.99951- 8999.99609	847.99976 847.99976-	3479.99976 INFINITY-	XP11P6 XP10R9	UL LL
186	XP10P7	EQ	.	2096.00000	. .	12999.99609- 2528.00000	1471.99976 1471.99976-	3567.99976 INFINITY-	XP11R9 XP11P13	LL LL
187	XP10P8	EQ	.	1216.00000	. .	12999.99609- 2528.00000	2351.99976 2351.99976-	3567.99976 INFINITY-	XP11R9 XP11P13	LL LL
188	XP10P9	EQ	.	3160.00000	. .	12999.99609- 2528.00000	407.99976 407.99976-	3567.99976 INFINITY-	XP11R9 XP11P13	LL LL
189	XP11P1	LL	.	4552.00035	. 201583.97899	54471.98450- 2527.99942	1392.00011- 1392.00011	INFINITY 3160.00024	IP13 XP11P13	LL LL
190	XP11P2	LL	.	4151.99879	. 132935.98473	54471.98436- 2527.99915	992.00000- 992.00000	INFINITY 3159.99879	IP13 XP11P13	LL LL
191	XP11P3	EQ	.	4120.00000	. .	54471.99609- 2527.99951	960.00000- 960.00000	INFINITY 3160.00000	IP13 XP11P13	LL LL
192	XP11P4	LL	.	3535.99921	. 136687.99511	54471.99200- 2527.99917	375.99991- 375.99991	INFINITY 3159.99930	IP13 XP11P13	LL LL
193	XP11P5	EQ	.	3624.00000	. .	54471.99609- 2527.99951	464.00000- 464.00000	INFINITY 3160.00000	IP13 XP11P13	LL LL
195	XP11P7	UL	43807.96391	2911.99956	. 43807.99619	10664.01060- 46335.96330	248.00002 248.00002-	3159.99998 INFINITY-	IP13 XP11P13	LL LL
196	XP11P8	UL	12463.98905	2335.99991	. 12463.99824	42007.99235- 14991.98791	824.00006 824.00006-	3159.99997 INFINITY-	IP13 XP11P13	LL LL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. / ..UPPER LIMIT.	LOWER ACTIVITY / UPPER ACTIVITY	...UNIT COST.. / ...UNIT COST..	..UPPER COST.. / ..LOWER COST..	LIMITING / PROCESS.	AT / AT
197	XP11P9	LL	.	3344.00040	.	54471.96964-	184.00001-	INFINITY	IP13	LL
					17359.99599	2527.99896	184.00001	3160.00038	XP11P13	LL
198	XP11P12	LL	.	3216.00077	.	54471.96474-	56.00002-	INFINITY	IP13	LL
					108579.94757	2527.99833	56.00002	3160.00075	XP11P13	LL
199	XS2P12	EQ	.	5552.00000	.	.	1428.00000-	INFINITY	XP11R15	LL
					.	2527.99951	1428.00000	4124.00000	XP11P13	LL
200	XS3P12	EQ	.	3016.00000	.	.	375.99976-	INFINITY	XP11R15	LL
					.	2527.99951	375.99976	2640.00024	XP11P13	LL
202	XS2P13	EQ	.	2192.00000	.	.	1931.99976	4123.99976	XP11R15	LL
					.	2527.99951	1931.99976-	INFINITY-	XP11P13	LL
203	XS3P13	EQ	.	2432.00000	.	.	208.00000	2640.00000	XP11R15	LL
					.	2527.99951	208.00000-	INFINITY-	XP11P13	LL
204	XP11P14	LL	.	4671.99877	.	54471.99198-	1511.99990-	INFINITY	IP13	LL
					73791.99635	2527.99943	1511.99990	3159.99886	XP11P13	LL
205	XP11P15	EQ	.	6208.00000	.	54471.99609-	3048.00000-	INFINITY	IP13	LL
					.	2527.99951	3048.00000	3160.00000	XP11P13	LL
211	IP6	LL	.	3000.00000	.	679.99951-	88.00000-	INFINITY	XP11P6	UL
					NONE	15000.00000	88.00000	2912.00000	XP11P6	LL
215	IP10	LL	.	3000.00000	.	2527.99951-	3567.99976-	INFINITY	XP11P13	LL
					NONE	12999.99609	3567.99976	567.99976-	XP11R9	LL
216	IP11	LL	.	3000.00000	.	2527.99951-	3159.99976-	INFINITY	XP11P13	LL
					NONE	54471.99609	3159.99976	159.99976-	IP13	LL

SECTION 3 - ROWS AT INTERMEDIATE LEVEL

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
36	MBS2	BS	10000.00000	.	NONE 10000.00000	10000.00000 10000.00000	INFINITY 555.99976		NONE MBPIO	 UL

SECTION 4 - COLUMNS AT INTERMEDIATE LEVEL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
39	XP1R1	BS	9999.99812	2255.99993	. 46799.99864	9999.99812 9999.99812	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
52	XP11R2	BS	1999.99880	4192.00002	. 26559.99707	1999.99880 1999.99880	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
59	XP10R3	BS	4999.99935	4015.99971	. 30303.99987	7999.99791- 4999.99935	1039.99940 INFINITY	5055.99911 INFINITY-	XP3R3 NONE	LL
67	XP10R4	BS	15999.99857	3407.99981	. 17999.99948	15999.99857 15999.99857	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
70	XP3R5	BS	4999.99985	1359.99992	. 5999.99983	4999.99985 4999.99985	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
83	XP11R6	BS	11999.99230	3631.99981	. 132935.98473	. 11999.99230	1519.99969 INFINITY	5151.99950 INFINITY-	XP2R6 NONE	LL
86	XP4R7	BS	18799.99584	2287.99907	. 132935.98473	18799.99584 27999.97948	INFINITY 1752.00153	INFINITY 535.99754	NONE XP11R7	 UL
98	XP11R8	BS	14999.99969	3247.99981	. 30484.99940	14999.99969 14999.99969	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
102	XP10R9	BS	8999.99722	2687.99994	. 46831.99659	8999.99722 13999.99477	555.99959 1039.99949	3243.99954 1648.00045	MBP10 XP3R3	UL LL
103	XP11R9	BS	12999.99773	2279.99973	. 28439.99796	7999.99936 12999.99773	1039.99902 555.99985	3319.99874 1723.99988	XP3R3 MBP10	LL UL
112	XP11R10	BS	5999.99965	3935.99988	. 60479.99986	5999.99965 5999.99965	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
122	XP11R11	BS	14999.99152	3327.99871	. 89711.96326	14999.99152 14999.99152	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
131	XP11R12	BS	9999.99453	3368.00067	. 149879.95075	44471.97365- 9999.99453	3775.99994 INFINITY	7144.00061 INFINITY-	XP7R12 NONE	LL
143	XP14R13	BS	9999.99957	2623.99975	. 37391.99875	848.00985 9999.99957	1876.00038 INFINITY	4500.00013 INFINITY-	XP13R13 NONE	LL
149	XP11R14	BS	8999.99854	3751.99987	. 37391.99875	8999.99854 8999.99854	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	
157	XP11R15	BS	.	3535.99891	. 96667.97464	. .	555.99980 INFINITY	4091.99871 INFINITY-	MBP10 NONE	UL

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT. / ..UPPER LIMIT.	LOWER ACTIVITY / UPPER ACTIVITY	...UNIT COST.. / ...UNIT COST..	..UPPER COST.. / ..LOWER COST..	LIMITING PROCESS.	AT / AT
159	XS2R15	BS	9999.99164	4499.99976	.	9999.99164	INFINITY	INFINITY	NONE	
					82367.96461	9999.99164	555.99984	3943.99992	MBP10	UL
160	XS3R15	BS	9999.99586	3016.00014	.	9999.99586	1483.99982	4459.99997	MBS3	UL
					69367.99666	9999.99586	INFINITY	INFINITY-	NONE	
162	XP11R16	BS	9999.99067	4440.00251	.	9999.99067	INFINITY	INFINITY	NONE	
					68895.95410	9999.99067	INFINITY	INFINITY-	NONE	
169	XP13R17	BS	6999.99844	3984.00021		6999.99844	INFINITY	INFINITY	NONE	
					43807.99619	6999.99844	INFINITY	INFINITY-	NONE	
176	XP15R18	BS	12999.99948	3679.99973	.	12999.99948	INFINITY	INFINITY	NONE	
					41999.99876	12999.99948	INFINITY	INFINITY-	NONE	
178	XP11R19	BS	24999.98934	6207.99988		24999.98934	INFINITY	INFINITY	NONE	
					137983.96062	24999.98934	INFINITY	INFINITY-	NONE	
194	XP11P6	BS	14999.99848	3072.00000	.	39471.97222-	88.00002	3160.00002	IP6	LL
					15679.99847	14999.99848	INFINITY	INFINITY-	NONE	
201	XP11P13	BS	2527.99954	3159.99932	.	12471.99293-	56.00001	3215.99932	XP11P12	LL
					260352.98635	17527.99669	87.99995	3071.99936	IP6	LL
206	IP1	BS	109999.93750	3000.00000	.	107471.93823	1392.00000	4392.00000	XP11P1	LL
					NONE	109999.93750	INFINITY	INFINITY-	NONE	
207	IP2	BS	27999.99609	3000.00000	.	25471.99707	992.00000	3992.00000	XP11P2	LL
					NONE	39999.98438	1519.99902	1480.00098	XP2R6	LL
208	IP3	BS	18999.99609	3000.00000	.	18999.99609	INFINITY	INFINITY	NONE	
					NONE	23999.99219	1039.99927	1960.00073	XP3R3	LL
209	IP4	BS	78800.00000	3000.00000	.	76272.00098	375.99976	3375.99976	XP11P4	LL
					NONE	87999.98828	1752.00049	1247.99951	XP11R7	LL
210	IP5	BS	29999.99609	3000.00000	.	29999.99609	INFINITY	INFINITY	NONE	
					NONE	29999.99609	INFINITY	INFINITY-	NONE	
212	IP7	BS	256192.00000	3000.00000	.	256192.00000	INFINITY	INFINITY	NONE	
					NONE	299999.96094	248.00002	2751.99998	XP11P7	UL
213	IP8	BS	22536.00000	3000.00000	.	22536.00000	INFINITY	INFINITY	NONE	
					NONE	34999.98828	824.00000	2176.00000	XP11P8	UL
214	IP9	BS	29999.99609	3000.00000	.	27471.99731	184.00000	3184.00000	XP11P9	LL
					NONE	29999.99609	INFINITY	INFINITY-	NONE	
217	IP12	BS	14999.99609	3000.00000	.	12471.99780	56.00002	3056.00002	XP11P12	LL
					NONE	14999.99609	INFINITY	INFINITY-	NONE	

NUMBER	.COLUMN.	AT	...ACTIVITY...	...INPUT COST..	..LOWER LIMIT. ..UPPER LIMIT.	LOWER ACTIVITY UPPER ACTIVITY	...UNIT COST.. ...UNIT COST..	..UPPER COST.. ..LOWER COST..	LIMITING PROCESS.	AT AT
218	IP13	BS	54471.99609	3000.00000	. NONE	39472.00000 56999.99438	88.00000 56.00002	3088.00000 2943.99998	IP6 XP11P12	LL LL
219	IP14	BS	54999.99609	3000.00000	. NONE	52471.99683 54999.99609	1511.99976 INFINITY	4511.99976 INFINITY-	XP11P14 NONE	LL
220	IP15	BS	32999.99609	3000.00000	. NONE	32999.99609 32999.99609	INFINITY INFINITY	INFINITY INFINITY-	NONE NONE	

INTER-ISLAND RICE DISTRIBUTION PLAN IN INDONESIA

by

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ABSTRACT

The geographic distribution of rice production and consumption in Indonesia creates an inter-regional rice shipping system of great complexity. The purpose of this study is to develop a rice distribution planning approach, which has minimal operating costs, based on given forecast data for one year. Currently, conventional methods for dealing with the decisions related to this problem rely quite heavily on intuitive judgment.

The following approach is presented to solve the problem. First, a one year planning horizon is selected. Then the distribution problem is solved by using linear porgramming. The model is used to select the optimal shipping pattern where supply and demand are balanced and the inter-port shipping capacities are included. The actual shipping schedule is obtained from this solution by adjusting it to satisfy the following constraints: 1) number of ship trips available, 2) warehouse capacities, 3) seasonal domestic supplies, 4) demand fluctuations and 5) loading and unloading capacities. The reason these last constraints are not included in the original problem is that the model would require integer solutions and there is no program available to solve large integer programming problems. These constraints are added by an interactive process where the solutions are modified slightly to accommodate each with the hope that near optimal schedules are obtained.

This problem has not been solved previously. The above approach is a first attempt to do so. The development of the distribution model with the appropriate constraints and the iterative approach for finding workable solutions is new.