Optimization of Rice Distribution Using a Linear Programming Model at Perum Bulog, West Java Regional Division, Indonesia

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Abstract

Good distribution network management is a very important competitive advantage for a company. The distribution that is not right with the wrong time will also have a big impact on all aspects, especially company profits. The exact number and timing are crucial points in the distribution. The distribution and transportation system must be designed optimally so that the minimum cost is obtained. Perum Bulog, West Java Regional Division, is the government's representative in distributing rice evenly and distributing rice, which is a staple food commodity for Indonesian people in general. Of course, it must pay attention to optimal distribution patterns. In carrying out the operational process, the West Java Regional Division of Perum Bulog will be assisted by 7 Regional Sub-Divisions scattered throughout the West Java region who will handle rice in their respective working areas. This study aims to determine the planning path and the optimum amount of rice distribution from the West Java Regional Division to districts and cities that can minimize distribution costs so that the costs incurred will reach their lowest point using the Linear Programming method. The analysis of this research was assisted by the LINDO software version 7.0 for Windows 10.0. From the results of this research, the optimization of rice distribution at Perum Bulog Divre West Java, with the optimum total distribution cost is IDR 6,374,025 360.

Keywords

Rice, Distribution, Transportation Method, Linear Program, LINDO.

Introduction

Food is anything that comes from biological resources and water, both processed and unprocessed, which is intended as food or drink for human consumption. In Indonesia, food is synonymous with rice. Adequacy of food for the community is a human right that must be fulfilled, and the government as the state administrator has the responsibility to fulfill it. This is in accordance with the mandate of Article 33 paragraph 3 of the 1945 Constitution which mandates the government as state administrator to optimize the management of natural resources owned by the state for the welfare of its people. Perum Bulog Regional Division of West Java, which is a state institution assigned to implement and control rice stocks in sufficient quantities through policies that are implemented. Perum Bulog West Java Regional Division has two tasks, namely public duties and commercial or business tasks. In public duties, Perum Bulog West Java Regional Division carries out government assignments, namely business activities to provide goods and/or services needed by the community, while in commercial assignments, Perum Bulog seeks to gain profit. Perum Bulog West Java Regional Division as a State-owned Enterprise (SOE) is still not optimal in carrying out its function in terms of creating profits for the government. This can be seen in the trend that tends to be negative in the financial reports obtained by Perum Bulog. Profits that are not optimal can be caused by several factors, one of which is an ineffective and efficient distribution system.

These conditions can result in uneconomic selling prices for commodities, making it difficult to compete and resulting in the erosion of company profits. In the management of food availability, especially rice, distribution in the right amount and time is a crucial point (Jamaludin et al., 2021). This is caused by an improper distribution process and has a major impact on all aspects, especially profit for the company. At this time the ability to manage distribution networks is a competitive advantage that is very important for a company. Distribution is a part of logistics, carrying out a fundamental function for a company. Distribution activities which include transportation activities can incur costs of 50% - 60% of the total logistics costs and the rest are cost components in inventory. This is also reinforced by Frazelle (2002), that transportation is the most expensive logistics activity. The costs generated by these activities are more than 40% of the total logistics costs. Therefore, the distribution and transportation system must be designed as optimally as possible so that the minimum cost is obtained. Perum Bulog, Regional Division of West Java, as an independent body in carrying out its functions, should pay attention to the efficiency of distribution costs, in this case transportation costs, in accordance with economic principles and transparent accountability. Therefore, in carrying out efficiency in transportation costs, Bulog West Java Regional Division must know the best route and the optimum number of shipments so that transportation costs can be minimized. This becomes the basis for research on what are the best route and the optimum number of shipments as a form of optimization that can be done and applied to the distribution of Bulog rice in the West Java Regional Division.

Literature Review

Distribution

Distribution is one aspect of marketing. Distribution can also be defined as a marketing activity that seeks to facilitate and facilitate the delivery of goods and services from producers to consumers, so that their use is in accordance with what is needed (type, quantity, price, place, and when needed). The concept of distribution is the activity of moving products from the source to the end consumers with distribution channels at the right time (Assauri, 2004; Jamaludin et al., 2020). Meanwhile, according to Kotler (2012) Distribution is a group of organizations that make a process of distributing goods or services that are ready to be used or consumed by consumers. With this distribution activity, it is hoped that it can make the distribution of goods or services from producers to consumers more easily achieved by consumers and producers. This distribution activity can be an activity that is very helpful between producers and consumers because without this activity it will be very difficult to achieve marketing activities between producers to consumers directly or indirectly.

Optimization is one of the disciplines in mathematics that focuses on obtaining minimum or maximum values systematically from a function, opportunity, or the search for other values in various cases. Optimization is very useful in almost all fields in order to do business effectively and efficiently to achieve the target results to be achieved. Linear optimization is the determination of the extreme values of a linear function of maximization and minimization problems. In general, optimization problems are divided into two types of optimization with constraints (Nasendi & Anwar, 1985). The problem of optimization with constraints is basically a matter of determining the various variable values of a function to be a maximum or a minimum by taking into account existing limitations.

Transportation Method

The transportation method is a special form of linear programming. This method is used to distribute a product from the producing area to a number of destination areas so that the costs incurred are minimized. The definition of transportation model according to Taha (2007) is a special part of a linear program that discusses the transportation of commodities from source to destination with the aim of finding a transportation pattern that can minimize total transportation costs in meeting supply and demand limits. This model deals with the lowest cost plan for delivering products from manufacturers to a number of destinations. The transportation model seeks to determine a transportation plan for an item from the source area to a number of destinations. The data in this model includes: (1) the level of supply from the source area and the number of requests from each destination; (2) transportation costs per unit of goods from source to each destination. According to Tarliah & Dimyati (1994), the specific characteristics of transportation problems are: (1) there are source and destination areas; (2). the quantity of commodities or goods distributed from the production source area and demanded by each particular destination; (3). Commodities sent or transported from a source to one destination are in accordance with the demand or source capacity; (4) the cost of transportation from a source to a destination is of a certain amount. A transport model of a network with m sources and n destinations. A source and destination are represented by a node. The arc that connects a source and destination represents the route of delivery of the item. The quantity of supply at source i is a_1 and the demand at destination j is b_1. The unit cost of transport between source i and destination j is C_{ij}. Assume that X_{ij} represents the quantity of goods shipped from source i to destination j.

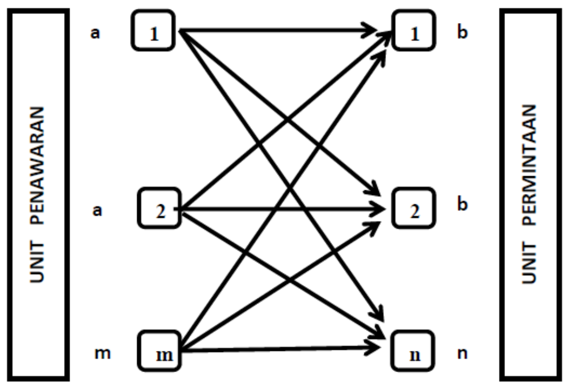

Figure 1 Network Transport Model with m sources and n destinations

Linear Programming

According to Nasendi & Anwar (1985), Linear Programming (LP) is essentially an analytical planning point using mathematical models, with the aim of finding several alternative combinations to solve problems and then selecting the best alternative. The selection of the best alternative is closely related to the allocation of limited resources and funds in order to achieve the company's goals or objectives optimally. So that a problem at hand can be compiled and formulated into a linear program model, there are five conditions that must be met, namely: (1) the objectives of the problem at hand or to be achieved must be clear and firm; (2) there must be one or several alternatives that can be compared; (3). limited resources analyzed; (4) functions and constraints must be quantitatively formulated into a model; (5) between the variables that make up the objective function and the constraints must fulfill the functional relationship or engagement relationship. There are some basic assumptions that underlie LP, namely, linearity, proportionality, additivity, disvisibility, determinism, and resource decision variables can be calculated.

Previous research that is relevant to this current research is Bosona et al., (2011), research using transportation methods and a linear programming approach to minimize shipping costs and provide an overview of LPF flow routes from producers to consumers who provide solutions most optimal. Fagoyinbo et al., (2011) who examined profit maximization using the simplex method with a linear programming approach, the purpose of this research was to determine the best allocation of raw material resources with the aim of maximizing profits. Ajibode & Fogoyinbo (2010), examined resource minimization using a linear program, the purpose of this study was to find the best decision making.

Distribution optimization researched by Apaydin & Gonoullu (2007) states that one of the techniques that can be used to minimize distribution costs is the transportation method, with this method the transportation route can also be optimized. Likewise, research conducted by Pratiwi et al., (2012) concludes that the distribution costs of LPG can be drunk using the transportation method and with a linear programming approach. Distribution costs alone can be reduced by about 20%. Akay (2004), with research which states that the linear programming method can provide a viable and efficient alternative solution in determining a good route design. The linear programming method has also been carried out by Murugan and Manivel (2009), in their research they analyzed the application of LP as a technique for decision making in production problems in companies that produce textiles and non-textiles. The purpose of this study is to maximize profit by determining the allocation of material costs, raw, labor allocation costs and overhead.

Research Methods

The research method used in this research is quantitative descriptive method with Linear Programming approach. Conceptual definition is the meaning of the concepts used to facilitate research. The conceptual definitions used include: (1) the decision variable is an equation which is the most optimal final result, the result is a certain target number whose maximum or minimum value with the unit of measurement is kilograms or tonnes; (2) the objective function variable is a mathematical inequality or equation that reflects the objectives to be achieved which will be measured in rupiah units; (3) the constraint function variable shows the mathematical function that becomes the constraint in maximizing or minimizing the objective function which will use the unit of measurement in kilograms or tons.

The populations in this study were all prosperous rice sent from the Regional Division (Drive) of Perum BULOG West Java to all cities and regencies in the work area of each of the Sub Drive. Sampling is saturated sampling because all populations are used as samples.

Secondary data obtained from company documents BULOG regional division of West Java and BPS for West Java as well as from other sources related to research variables will be collected in tabulations and grouped according to the variables. The data will then be processed as needed so that it can be applied to the research variables. Technical analysis of data using Linear Programming (LP) which will include data, namely: Data on distribution costs, which includes transportation costs from the Sub Division of each Drive, or data on the distance between warehouse locations, data on demand/shortage of rice stocks for each city and regencies in West Java, rice stock procurement data for each Sub Drive. In general, the LP mathematical model can be stated as follows:

Purpose Function :

Minimize Transportation Costs :

$$\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_{ij}$$

Constraint Function :

Procurement Constraints :

$$\sum_{j=1}^{n} X_{ij} \leq S_i$$

Request Constraints :

$$\sum_{i=1}^{m} X_{ij} = D_j$$

Where:

S_i = Amount of rice procurement in the i-Sub Divre (Ton).

D_j = Demand for rice from the jth city/regency (tonnes).

C_{ij} = Transportation costs from the Sub Divre (i) to the destination city/regency j (Rp/ton).

X_{ij} = Amount of rice transported from Sub Divre - i to jth destination regencies and cities (tonnes).

$$\sum_{j-1}^{n} X_{ij} \leq S_i$$

The steps involved in data processing are as follows: (1) analysis of transportation methods; (2) data sampling analysis; (3) solving transportation problems with LP and LINDO software; (4) determine the optimal solution; (5) draw conclusions.

Results and Discussion

Rice Distribution Pattern in West Java

Based on the results of the BPS survey for the West Java region, rice mills in West Java obtain unsullied/rice and then milled it into rice from surrounding provinces, namely East Java, Central Java and from within the territory of West Java Province itself, which is 56% percent. Rice as a result of production is then sold mostly to West Java Province itself, amounting to 53%. The remaining 47% is sold to DKI Jakarta.

The distribution pattern of rice in West Java involves traders, collectors, distributors, sub distributors, agents, sub agents, wholesalers and retailers. Meanwhile, the final consumers of rice consist of the processing industry, other business activities, government and non-profit organizations, and households. Distributors obtain rice supplies from producers and then sell the rice to various rice businesses. The percentage of distribution sharing from rice producers in West Java is 83% to wholesalers, 4% to collectors, and 9% to retailers. Furthermore, it is 4% for distribution to households and for the processing industry by 0.3 percent. According to the Central Statistics Agency (2018), the West Java region rice production in West Java in 2018 was around 13,073,152 tons, an increase of about 7 percent from the previous year. This is due to an increase in the area of agricultural land for rice fields and fields in several districts in West Java.

Optimization of Distribution Costs in West Java

The process of distributing rice by BULOG West Java Regional Division is based on the division of the Sub Drive work area in 7 districts and cities such as the Bandung City Sub-drive, the Karawang Sub-Division, and the Subang District Sub-Division, the Cirebon Regency Sub-Division, the Indramayu Regency Sub-drive, the Cianjur Regency Sub-drive and Sub drive of Ciamis Regency. The procurement of rice in West Java is influenced by external factors such as the area of rice plantations, harvested area, and level of pest attack, season, land productivity and crop distribution. As a result, rice procurement will fluctuate from time to time. This condition will cause the allocation of rice distribution from surplus areas to areas minus rice supplies. The level of distribution of the Sub Drive is determined by the number of budget and non-budget groups covered by its working area. Distribution costs from each Sub Drive to regency cities in their respective working areas, the amount of procurement and requests are described below in table 1.

Table 1 Distribution, Procurement and Demand Costs in 2019

City	**Transportation Cost (Rp/Kg)**							**Demand (ton)**
purpose	**Bandung**	**Cianjur**	**Cirebon**	**Indramayu**	**Karawang**	**Subang**	**Ciamis**	
Karawang	23,408	30,723	38,456	28,006	2,090	18,810	48,697	29,063
Bekasi	32,186	31,559	47,861	36,784	8,778	27,588	52,877	27,781
Sukabumi	20,064	6,688	47,234	58,520	35,948	8,778	45,353	35,405
Cianjur	13,585	4,389	40,755	52,041	30,723	8,151	38,874	37,992
Garut	13,167	26,752	32,813	44,099	36,572	25,289	15,466	32,803
Bogor	26,961	15,466	54,131	65,417	20,064	38,874	52,250	35,081
Tasikmalaya	22,154	35,739	25,080	36,366	45,562	34,276	3,553	32,940
Ciamis	25,289	38,874	21,527	32,813	48,697	37,411	4,389	16,988
Bandung	6,270	13,585	37,620	38,456	23,408	12,122	25,289	60,499
Kuningan	34,485	48,070	7,315	18,601	45,771	39,919	14,212	15,908
Cirebon	27,170	40,755	7,524	11,286	38,456	32,604	21,527	34,904
Majalengka	19,019	32,604	12,749	17,138	42,427	31,141	17,556	17,924
Sumedang	9,405	22,990	17,765	29,051	23,408	12,749	27,170	13,341
Indramayu	38,456	52,041	11,286	3,971	28,006	21,318	32,813	31,320
Subang	12,122	8,151	32,604	21,318	18,810	4,807	37,411	22,578
Purwakarta	14,630	20,691	41,800	27,170	8,778	10,032	36,784	8,704
Pangandaran	42,218	54,277	31,350	41,800	56,430	45,144	12,958	5,061
Depok	34,903	19,437	49,324	47,443	17,974	29,678	60,401	7,399
Cimahi	4,389	11,913	43,681	41,591	17,347	24,035	26,961	3,408
Banjar	34,067	42,970	22,990	35,321	48,488	35,948	5,225	1,743
Procurement	48,844	40,230	1,32,289	75,105	66,043	45,322	101,53	

The table above provides an overview of the pattern of rice procurement by BULOG West Java Regional Division. The purchase of rice is carried out through the Farmers' Working Partners (MKP), the Procurement Task Force (SATGAS) and the Grain and Rice Processing Unit (UPGB) owned by Perum BULOG which is spread across West Java. The rice procurement trend is different for each Sub Divre. The lowest rice procurement was Sub Divre Cianjur which amounted to 40,230 tons, while the highest rice procurement was carried out by Sub Divre Cirebon which amounted to 132,289 tons. This is directly proportional to the large population so that rice consumption also increases. The rice procurement referred to here is the rice procurement carried out by the Sub-Division in

West Java Province. The rice procurement carried out by the Sub Divre is related to government policies to provide national rice stocks and support market price fixing. The market price fixing policy is the government's effort to protect producer farmers, especially during the harvest season. In accordance with the law of supply and demand, a fixed level of product demand while increasing supply will cause supply to tend to push prices down. The greater the supply that occurs, the effect on the decline in prices will be even greater. The government will purchase rice to absorb the existing supply so that prices are expected to move to the original equilibrium point. In accordance with the principle of domestic rice procurement, the government is obliged to buy rice from farmers if the price in the market is lower than the market price set by the government.

Demand for rice in every district and city in West Java is different from one another. One of the objectives and functions of BULOG is the distribution of prosperous rice (RASTRA). The provision of rice in each BULOG warehouse is adjusted to the distribution of prosperous rice in its working area, so that the distribution of prosperous rice can be guaranteed. The need for rice in West Java, in this case rastra rice for each beneficiary household is as much as 15 Kg/month. The total need for prosperous rice for the regional division of West Java is 470,842,200 Kg. The largest demand came from the City/Regency of Bandung with 60,499 tons, followed by Cianjur Regency with 37,992 tons and Sukabumi City/Regency with 35,405 tons.

The results of implementing the Linear Programming model are the output of a mathematical model based on procurement and demand constraints to obtain the optimal solution. In analyzing the output of LINDO Version 7.0 for Windows, there are 3 (three) analyzes that will be carried out, namely primal analysis (reduced cost), dual analysis (slack/surplus) and sensitivity analysis.

Reduced Cost Value

Reduced cost is the amount of the cost of changing the optimal value of the destination function if a number of products, in this case rice, should not be sent but are sent from certain sources. If a product that has a reduced cost is more than zero, then shipping activities from that source are not profitable. However, if reduced cost is zero, it means that the delivery of the product is profitable. The reduced cost value on the output of LINDO ver 7.0 for Windows is shown in table 2.

Table 2 Reduced Cost (Primal Analysis)

Variable	Value	Reduced Cost
X14	45,436	0
X119	3,408	0
X21	13,379	0
X23	26,851	0
X33	1,223	0
X34	3,060	0
X38	15,908	0
X39	34,904	0
X310	17,924	0
X311	13,341	0
X318	7,399	0
X412	31,320	0
X413	22,578	0
X414	8,704	0
X415	12,503	0
X51	21,702	0
X515	16,560	0
X516	27,781	0
X62	35,404	0
X63	9,917	0
X74	12,003	0
X75	32,803	0
X76	32,940	0
X77	16,988	0
X717	5,061	0
X720	1,743	0

From the table above it can be seen that the quantum of delivery that can minimize distribution costs are X14, X119, X21, X23, X33, X34, X38, X39, X310, X311, X318, X412, X413, X414, X415, X51, X515, X516, X62, X63, X74, X75, X76, X77, X717 and X720. The reduced cost value for all shipments from source to destination in the table above is 0, so distribution costs will be the minimum.

Dual Analysis (Slack/Surplus)

Dual analysis is carried out to determine the assessment of existing resources and assess decisions by assessing shortages (slack) or excess (surplus) indicating that the addition of one unit of resource will increase the value of the objective function by the value of its dual value. The slack variable will relate to the constraint and represent the amount of excess on the right side of the constraint compared to the left side, while the surplus variable is the excess limit on the left side compared to the right side. If the slack or surplus value is greater than zero and the dual value is equal to zero, then the variable or resource can be categorized as an excess resource or not a constraint. The dual analysis of LINDO's output results is presented in table 3.

Table 3 Slack or Surplus (Dual Analysis)

Variable	Row	Slack or Surplus	Dual Price
Supply	1	0	31350
	2	0	36366
	3	38530	0
	4	0	5852
	5	0	31768
	6	0	32604
	7	0	12331
Demand	8	0	-51832
	9	0	-41382
	10	0	-40755
	11	0	-37620
	12	0	-27797
	13	0	-15884
	14	0	-16720
	15	0	-7315
	16	0	-7524
	17	0	-12749
	18	0	-17765
	19	0	-9823
	20	0	-27170
	21	0	-33022
	22	0	-33858
	23	0	-40546
	24	0	-25289
	25	0	-49324
	26	0	-35739
	27	0	-17556

From the table presented in the table above, it can be seen that there is a surplus in row 3 of 38,530 tons. This means that there is an excess stock of rice at that value. The excess supply is in the Cirebon Sub Division. Cirebon Sub Divre itself is the largest supplier of rice compared to other Sub Divre in West Java.

Sensitivity Analysis

Describe the extent to which the objective variable and the value of the right-hand side of the constraint variable may change without affecting the optimal value. The sensitivity analysis consists of the analysis of the coefficient of the objective variable which explains the change in the value of the objective variable that does not change the optimal value of the decision variable. The effect of change can be seen from the range of the minimum sensitivity (allowable decrease) and the range of maximum sensitivity (allowable increase). The sensitivity analysis of the internal and objective variables can be seen in table 4.

Table 4 Constraint Sensitivity Analysis

No	Variable	RHS* Value	Allowable Increase	Allowable Decrease	Status
1	Supply	48.844	3.060	38.530	**Sensitive**
2	Supply	40.230	1.223	26.851	**Sensitive**
3	Supply	132.289	Infinity	38.530	**Not Sensitive**
4	Supply	75.105	1.223	12.503	**Sensitive**
5	Supply	66.043	1.223	21.702	**Sensitive**
6	Supply	45.322	1.223	9.918	**Sensitive**
7	Supply	101.538	3.060	12.003	**Sensitive**
***RHS=Righthand side**					

Based on the results of the data tabulation of the procurement constraints variable above, almost all of them are sensitive to optimization of distribution costs, which in this case is minimization. Only one variable is considered less sensitive, this is due to excess stock conditions compared to the number of requests. The mean minimum sensitivity range was about 1,573 and the maximum sensitivity range was 22,862. In the analysis of the sensitivity of the demand variable, all cities/districts are sensitive to changes in the optimization of goals, it can be seen that there is no minimum sensitivity interval or maximum sensitivity interval that is in the infinity status. The mean maximum sensitivity range is around 24,283, while the minimum sensitivity range is around 5,968.

The sensitivity analysis of the objective variables from the processed LINDO output can be seen in table 5 below.

Table 5 Sensitivity Analysis of Objective Variables

No	Variable	RHS Value	Allowable Increase	Allowable Decrease	Status
1	X14	6270	4180	3553	Sensitive
2	X119	4389	3553	INFINITY	Not Sensitive
3	X21	15466	1463	418	Sensitive
4	X23	4389	418	1463	Sensitive
5	X33	40755	1463	418	Sensitive
6	X34	37620	4807	4180	Sensitive
7	X38	7315	17138	INFINITY	Not Sensitive
8	X39	7524	9614	INFINITY	Not Sensitive
9	X310	12749	10241	INFINITY	Not Sensitive
10	X311	17765	17138	INFINITY	Not Sensitive
11	X318	49324	418	INFINITY	Not Sensitive
12	X412	3971	1463	INFINITY	Not Sensitive
13	X413	21318	5434	INFINITY	Not Sensitive
14	X414	27170	7524	INFINITY	Not Sensitive
15	X415	28006	2090	1463	Sensitive
16	X51	20064	418	1463	Sensitive
17	X515	2090	1463	2090	Sensitive
18	X516	8778	2090	INFINITY	Not Sensitive
19	X62	8778	INFINITY	INFINITY	Not Sensitive
20	X63	8151	INFINITY	1672	Not Sensitive

The analysis of the sensitivity of the objective variables to optimize the cost of shipping rice above shows that the sensitivity interval of each variable is different from one another. Variables that are sensitive to changes in the objective variables include: X14, X21, X23, X33, X34, X415, X51, X515. This variable has an average maximum sensitivity interval of 2.206, and the average minimum sensitivity interval is 2.206. Variables that are less sensitive to changes in the objective function are X119, X38, X39, X310, X311, X318, X412, X413, X414, X516, X62, and X63. This shows that there are fewer sensitive variables than those less sensitive to the objective function.

With the constraints and assumptions used by the transportation model, and mathematical modeling with Linear Programming and data processing with the help of LINDO, the results are obtained in the form of planning rice distribution lines from each Sub Divre to districts and cities in West Java, as presented in table 6.

Table 6 Optimization Results of Rice Distribution in West Java

Code	Origin (Subdivre)	Purpose	Volume (ton)	Cost (IDR/ton)	Total cost (IDR)
X14	Bandung	Bandung	45,436	6,270	284,883,720
X119	Bandung	Cimahi	3,408	4,389	14,957,712
X21	Cianjur	Bogor	13,379	15,466	206,919,614
X23	Cianjur	Cianjur	26,851	4,389	117,849,039
X33	Cirebon	Cianjur	1,223	40,755	49,843,365
X34	Cirebon	Bandung	3,060	37,620	115,117,200
X38	Cirebon	Kuningan	15,908	7,315	116,367,020
X39	Cirebon	Cirebon	34,904	7,524	262,617,696
X310	Cirebon	Majalengka	17,924	12,749	228,513,076
X311	Cirebon	Sumedang	13,341	17,765	237,002,865
X318	Cirebon	Depok	7,399	49,324	364,948,276
X412	Indramayu	Indramayu	31,320	3,971	124,371,720
X413	Indramayu	Subang	22,578	21,318	481,317,804
X414	Indramayu	Purwakarta	8,704	27,170	236,487,680
X415	Indramayu	Karawang	12,503	28,006	350,159,018
X51	Karawang	Bogor	21,702	20,064	435,428,928
X515	Karawang	Karawang	16,560	2,090	34,610,400
X516	Karawang	Bekasi	27,781	8,778	243,861,618
X62	Subang	Sukabumi	35,404	8,778	310,776,312
X63	Subang	Cianjur	9,917	8,151	80,833,467
X74	Ciamis	Bandung	12,003	25,289	303,543,867
X75	Ciamis	Garut	32,803	15,466	507,331,198
X76	Ciamis	Tasikmalaya	32,940	3,553	117,035,820
X77	Ciamis	Ciamis	16,988	4,389	74,560,332
X717	Ciamis	Pangandaran	5,061	12,958	65,580,438
X720	Ciamis	Banjar	1,743	5,225	9,107,175
Total		470,840		**6,374,025,360**	

The results of the analysis of table 6 can be explained as follows distribution costs can be optimized if the Bandung Regional Divre sends deliveries to the Bandung and Cimahi areas, the Cianjur Sub-Division will supply the Bogor and Cianjur Areas, the Cirebon Sub Divre Areas will distribute to the Regions Cianjur, Bandung, Kuningan, Cirebon, Majalengka, Sumedang and Depok. For the Indramayu Sub Divre Region, it will distribute to the Indramayu, Subang, Purwakarta and Karawang areas. The Karawang Sub Divre will make deliveries for the Bogor, Karawang and Bekasi areas. Furthermore, the Subang Divre Region will distribute to the Subang and Cianjur Region, and the last is the Ciamis Sub Divre Region which will make deliveries to the Bandung, Garut, Tasikmalaya, Ciamis, Pangandaran and Banjar areas. The volume of rice transported will be in accordance with the amount of demand because the overall amount of supply is greater than the total demand. Then the most optimum distribution cost with all the demand met with the best route is IDR 6,374,025,360.

These results are in accordance with the results of research from Fagoyinbo et al., (2011) which states that the use of the simplex method with the linear programming approach will maximize profits and minimize production costs. The results of the research by Ajibode & Fagoyinbo (2010) using the linear programming method, the use of resources can be minimized. The same conclusion is also obtained from the results of research by Bosona et al., (2011), that the best shipping or transportation route can be determined using the transportation method, the improvements made can reach 93%. Faharani et al. (2013) states that the distribution network model can be optimized using transportation methods and linear programming, so that all requests can be met so that customer satisfaction can be maximized. In line with the research conducted by Liu et al. (2012) that the total logistics costs can be reduced and minimized, operational processes can also be carried out efficiently and effectively. Thus it can be seen that the advantages of Linear Program (LP) include: (1) Easy to use, especially when using computer aids; (2) Can use many variables, so that various possibilities to obtain optimal resource utilization can be achieved; (3) The objective function can be flexible according to the research objectives/data availability; (4) More practical than other programs; (5) The shadow price value can be generated at the same time, so that the price efficiency or allocated parameter can be seen, where the marginal production value (NPM) of input X will be the same as the price of the input X.

Conclusion

The distribution of rice carried out by Perum BULOG Sub Drive West Java will reach a minimum cost if the Bandung Sub Drive Region delivers to the Bandung and Cimahi Areas, the Cianjur Sub Drive Region will supply the Bogor and Cianjur Areas, the Cirebon Sub

Drive Region will distribute to the Region Cianjur, Bandung, Kuningan, Cirebon, Majalengka, Sumedang and Depok. For the Indramayu Sub Divre Region, it will distribute to the Indramayu, Subang, Purwakarta and Karawang areas. The Karawang Sub Drive will make deliveries for the Bogor, Karawang and Bekasi areas. Furthermore, the Subang Drive Region will distribute to the Subang and Cianjur Region, and the last is the Ciamis Sub Drive Region which will make deliveries to the Bandung, Garut, Tasikmalaya, Ciamis, Pangandaran and Banjar areas. The total distribution costs incurred amounted to IDR 6,374,025,360.

The optimum volume of rice sent to municipalities and regencies respectively, which is sent from Sub Drive Bandung to City/Regency Bandung is 45,436 tons, Cimahi is 3,408 tons. Sub Drive Cianjur sent to the city/regency of Bogor as much as 13,379 tons and Cianjur for 26,851 tons. The Cirebon Sub Divre sent 1,223 tons to the City/Regency, Bandung 3,060 tons, Kuningan 15,908 tons, Cirebon 34,904 tons, Majalengka 17,924 tons, Sumedan and Depok 13,341 tons and 7,399 tons respectively. Indramayu Sub Drive sent 31,320 tons to the City/Regency of Indramayu, 22,578 tons of Subang, 8,704 tons of Purwakarta, 12,503 tons of Karawang. The Karawang Sub Drive will send to the City/Regency of Bogor, Karawang and Bekasi with the respective shipping volumes of 21,702 tons, 16,560 tons and 27,781 tons. Subang Drive Subang will ship to Sukabumi and Cianjur with a shipping volume of 35,404 tons and 9,917 tons. The Cianjur sub-division will deliver to the city/regency of destination Bandung for 12,003 tons, 32,803 tons of Garut, 32,940 tons of Tasikmalaya, 16,988 tons of Ciamis, 5,061 tons of Pangandaran and 1,743 tons of Banjar.

To achieve optimal shipping costs, it is recommended that the procurement of rice in each sub-division area should be increased in order to meet the demand in each work area as determined by BULOG West Java Regional Division. The results of this study indicate that the most significant reduction in transportation costs is if each Sub-Division can supply rice needs in their respective working areas.

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