An Optimization Model For Strategy Decision Support to Select Kind of CPO’s Ship

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Abstract. The selection of marine transport for the distribution of crude palm oil (CPO) is one of strategy that can be considered in reducing cost of transport. The cost of CPO’s transport from one area to CPO’s factory located at the port of destination may affect the level of CPO’s prices and the number of demands. In order to maintain the availability of CPO a strategy is required to minimize the cost of transporting. In this study, the strategy used to select kind of charter ships as barge or chemical tanker. This study aims to determine an optimization model for strategy decision support in selecting kind of CPO’s ship by minimizing costs of transport. The select of ship was done randomly, so that two-stage stochastic programming model was used to select the kind of ship. Model can help decision makers to select either barge or chemical tanker to distribute CPO.

Keywords: Optimization, Cost, Two – Stage Stochastic Programming Model

1. Introduction
Some of alternatives distribute CPO needs strategy for determine kind of ship and giving effect for determining cost to every companies. Ships as a maritime transportstion is more efficiently and environmentally friendly [14]. The modelling is difficult factors to affect of characteristics every kind of transport but The plan transportation is an activity of the selecting alternatives procurement of transport facilities to optimal [9].

One of problems in the distribute CPO has the cost of transporting which relatively large. Cost will affect to determine of cost production and the competitiveness of production. Distribute problems will be complex when it was uncertain problems. Solution to reduce of risk is minimizying cost of distribute CPO. The select either barge charters or chemical tanker charters are a startegy of decision which taken at random. Therefore, this study was used two-stage stochastic programming model.

2. Planning of CPO’s Transport
Transportation services related to safety, where the goods are a transported must remain infact until at destination. Parties involved in this study as CPO’s factory, shipowner, oil’s factory. Transport process of CPO’s ship was begins from CPO’s factory as shipper, and then CPO will transported to port by truck for loading process at terminal handling. Loading process was used pipeline system, where Pipeline system is a activity flow of CPO from storage tanks to ship. After ship was load at port, tenant is take care of all the technical requirements, administrative,
cost of marine transportation service, and have obtained a permit to sailing. If all matters have been fulfilled, then the company ship will dispatch ships to destination. Arriving at destination, cargo will be unloaded with equipment available. Unload Activity was pipeline system or truck losing. In event of damage or loss to cargo, then consequences occur will transferred in form of unexpected costs.

Voyage charter can be used as agreement, where in a voyage charter the shipowner gets fee based on the amount of cargo transported from $L_1$ to $L_2$ [6], therefore The cost of charter was calculated to number ships of cargo ships that transported and frequency of shipping. Shipowner will determine cost of charter based on time for one cruise. This study was used chemical tanker (9000-15,000 DWT) and barge (2000-8000 DWT). As Consideration, Chemical tanker has greater speed than by barge, but it needs fuel more. Otherwise barge required less fuel because it has lack of speed. The speed and amount of fuel required ship into consideration in minimize cost. Possible risks responded in the form of unexpected costs. Risks that may occur such as delay in arrival of goods, reduced volume of payload and damage of quality to charge.

3. Two-Stage Stochastic Programming Model
The purpose of model is determining a feasible solution model to the problem of uncertain. In this study, uncertainty is a plan of require time and transportation costs. The decision Stochastic programming model is an optimization method for modeling related to uncertain problems [2]. This study, two-stage stochastic programming model is formulated for two different stages. The first stage is analysis before the realization of uncertain events, while the second stage after uncertain events is realized. Mathematically, two-stage stochastic programming problem can be stated as :

$$\min : z = \sum_{j=1}^{n} c_j x_j + E(\sum_{i=1}^{m} P_i | y_i |)$$

$$subject to :$$

$$y_i = b_i - \sum_{j=1}^{n} a_{ij} x_j \quad i = 1, 2, ..., m$$

$$\sum_{j=1}^{n} r_{sj} x_j \geq h_s \quad s = 1, 2, ..., l$$

$$y_i \geq 0, \quad x_j \geq 0, \quad i = 1, 2, ..., m, \quad j = 1, 2, ..., n$$

where the model was assumed that the first stage of decision variables $x_j, j = 1, 2, ..., n$ and the second stage decision variables $y_i, i = 1, 2, ..., m$ are stochastic in the problem, otherwise $P_i, i = 1, 2, ..., m$ are probabilistic to select of ships.

4. The Model
The Model is a strategy to plan of distribute CPO from CPO’s factory to oil’s factory. The magnitude of CPO’s ships and the complexity of CPO production could affect to number of demands and price of CPO in Indonesian, so that decision makers has difficult to respon problem.
PARAMETERS

\( \alpha \) : The total cost to every ships (Rp)
\( P \) : Probability of unexpected costs to every ships
\( V \) : The set kind of CPO’s ships
\( Q_v \) : The amount of CPO’s cargoes to every ships (MT)
\( C^{VC} \) : The cost of charter ship per tonnage (Rp)
\( C^{Tb} \) : The cost of charter tugboat (Rp)
\( T^{VC} \) : Time of charter ships for a single voyage (days)
\( C^{TVS} \) : The total cost of charter ship at beginning of charter party (Rp)
\( b_1 \) : The total cost charged to tenant after ship arrives at port of destination (Rp)
\( C^s \) : Cost of fuel per tonnage to every ships (Rp)
\( H^s \) : The amount of fuel needed to every ships (Rp)
\( C^{FT} \) : The total cost of fuel to every ships (Rp)
\( b_2 \) : Budget of fuel costs to every ships (Rp)
\( T^{Port} \) : Time for loading and unloading at port (days)
\( C^{Port} \) : The cost of port to every ship per day (Rp)
\( C^{PT} \) : The total cost of port to every ships (Rp)
\( b_3 \) : Budget of port to every ships (Rp)
\( C^{TT} \) : The total cost of unexpected costs to every ships (Rp)

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\( I \) : Set of barge \((i = 1, 2, ..., n)\)
\( J \) : Set of Chemical Tanker \((j = 1, 2, ..., m)\)

DECISION VARIABLES

\( X_{v1} \) : Barge
\( X_{v2} \) : Chemical Tanker
\( Y_i \) : Binary variable 1 if barge has unexpected costs
\( Y_j \) : Binary variable 1 if chemical tanker has unexpected costs
\( \delta_{v1} \) : Binary variable 1 if barge was selected
\( \delta_{v2} \) : Binary variable 1 if chemical tanker was selected

In the above section, it has been described that selection of ship is done randomly, so two stage stochastic model as follows:

**Objective Function** :

\[
\min \quad z = \left( \sum_{i=1}^{n} \alpha_i X_{v1} + E\left( \sum_{i=1}^{n} P[y_i]\right) \right) \delta_{v1} + \left( \sum_{j=1}^{m} \alpha_j X_{v2} + E\left( \sum_{j=1}^{m} P[y_j]\right) \right) \delta_{v2} \tag{2}
\]
Subject to:

\[
C_i^{TT} = b_1 - \sum_{i=1}^{n} [(Q_i C_i^{VC} T_i^{VC}) + C_i^{Th}]
\]  \hspace{1cm} (3)

\[
C_j^{TT} = b_1 - \sum_{j=1}^{m} (Q_j C_j^{VC} T_j^{VC})
\]

\[
i = 1, 2, ..., n \text{ and } j = 1, 2, ..., m \forall i \in I, j \in J
\]

The above cost is calculation of determine following Y value:

\[
C_i^{TT} \in Y_i
\]

\[
C_j^{TT} \in Y_j
\]

Variable Y is binary variable which determining as decision support on describe that presence or absence of unexpected costs to every ships.

\[
Y = \begin{cases} 
1 & \text{if ship has unexpected costs} \\
0 & \text{if ship hasn’t unexpected costs}
\end{cases}
\]

Table 1. Strategy of determining presence or absence of unexpected costs

| Calculations result | Y |
|---------------------|---|
| \( C^{TT} < 0 \)   | 0 |
| \( C^{TT} > 0 \)   | 1 |

\[
\sum_{i=1}^{n} C^s H_i^s \leq b_2
\]  \hspace{1cm} (4)

\[
\sum_{j=1}^{m} C^s H_j^s \leq b_2
\]

\[
H_i^s > 0, \quad H_j^s > 0 \quad \forall \ i \in I, j \in J
\]

\[
\sum_{i=1}^{n} T_{i}^{Port} C_i^{Port} \leq b_3
\]  \hspace{1cm} (5)

\[
\sum_{j=1}^{m} T_{j}^{Port} C_j^{Port} \leq b_3
\]

\[
T_i^{Port} < T_i^{VC}, \quad T_j^{Port} < T_j^{VC} \quad \forall \ i \in I, j \in J
\]

\[
Q_{v_1} = Q_{v_2} \quad \forall \ v_1, v_2 \in V
\]  \hspace{1cm} (6)
\begin{align*}
X_{v_1} > 0, \quad X_{v_2} > 0 \quad \forall \ v_1, v_2 \in V \quad (7)
\end{align*}

\begin{align*}
\delta_{v_1} + \delta_{v_2} \leq 1 \quad \forall \ i \in I, j \in J. \quad (8)
\end{align*}

\(\delta\) is a decision variable to indicate kind of ship to be selected or not selected by comparing sum of every cost and expectation value.

\[
\delta = \begin{cases} 
1 & \text{if ship was selecting} \\
0 & \text{if ship wasn’t selecting}
\end{cases}
\]

Determination is one kind of the ships, it can be selected is assumed as follows:

Assumed:

\[
u = \sum_{i=1}^{n} \alpha_i X_{v_1} + E(\sum_{i=1}^{n} P[Y_i])
\]

\[
w = \sum_{j=1}^{m} \alpha_j X_{v_2} + E(\sum_{j=1}^{m} P[Y_j])
\]

Assignment of \(\delta_1\) or \(\delta_2\) was determining by analyze difference between two costs charged to ship with above assumptions.

\[
z = u - w
\]

\begin{table}[h]
\centering
\begin{tabular}{l|cc}
\hline
\multicolumn{1}{c|}{\(\delta_{v_1}\)} & \multicolumn{1}{c}{\(\delta_{v_2}\)} \\
\hline
\(z < 0\) & 1 & 0 \\
\(z > 0\) & 0 & 1 \\
\hline
\end{tabular}
\caption{Strategy select kind of ship}
\end{table}

Values of \(\delta_{v_1}\) and \(\delta_{v_2}\) will be projected on objective function. Subsequently obtained decision kind of ship to be used at lowest cost, where components of above model are limited to a single voyage.

Based on equation (2), Objective function is minimize cost for transporting CPO with strategy to select kind of ship. Decision to be taken is whether to barge charter or chemical tanker charter. Every ships has same of probability, so \(P_1 + P_2 + \ldots + P_n = 1\). \(\alpha\) is total cost of charter ship, cost of port, and cost of fuel ship.

\[
\alpha = [C^{TVC} + C^{PT} + C^{FT}]
\]

Based on equation (3), unexpected costs occur if total cost is greater than planned lease budget and agreed upon by tenants and shipowners \((b_1 > C^{TVC})\). Unexpected cost of model was shown in form of a binary variable \(\{0, 1\}\), provided that it is shown in table 1. Based on equations (4) and (5) shows respective total cost of fuel required and total cost of port. For the total
cost of port is some of the total costs incurred while at port such as navigation costs, loading and unloading costs, water costs, crew and skipper wages costs, etc. Based on equation (6) show total CPO will be distributed by barge must be equal to total CPO charge that will be distributed by chemical tanker. Based on equation (7) show that every kind of ship will represent calculation to minimize cost of transporting CPO and determine only one kind of ship charter for distribute CPO. Based on equation (8) aims at deciding what kind of ship to be used for transporting of CPO. Decision will be taken through provisions shown in table 2. The cost of truck is not included in model because cargo is transported in same volume, so the cost was same for distribute CPO. For route problem is not included in model, because model was restricted only to routes which both ship can pass.

5. Conclusion
Based on after chapters, the first stage of this study is analyzing all cost components before the realization of uncertain events, while in the second stage is analyzing unexpected cost as response of the risk on this study. The strategy of select one kind of ship was using binary variable \( \{0, 1\} \), so as to produce decision to select is one kind of CPO’s ships. If \( z < 0 \) then \( \delta_i = 1 \) and \( \delta_j = 0 \), otherwise if \( z > 0 \) then \( \delta_i = 0 \) and \( \delta_j = 1 \). Result of projected value \( \delta \) will be multiplied by every components of cost, then it will be seen what kind of ship will be selected with lowest cost. The lowest cost can be seen when The total cost of one ship to one kind of ship will be multiplied by number of CPO’s ship, and it was sum with the average value of unexpected cost. The average of value was determined after multiplication between probability of selected ship to same kind of ship with the unexpected cost to every ship.

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