Optimization Model in Logistics Planning and Supply Chain

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Abstract. The progress and success of the company can be seen from the consumer's response to production from all aspects of each company's activities and is a key success factor. In this case describes the problem of supply chain optimization from the perspective of providing logistics including a mathematical model of cost optimization for supply chains in the form of MILP (Mixed Integer Linear). Production, transportation and distribution costs are chosen as optimization criteria. Time, volume, capacity and mode of transportation are also taken into account. The model was developed based on supply chain management theory to achieve the lowest cost, responsive and to achieve common goals. The results state that product inventories, loading patterns, modes of transportation, and minimum order quantities significantly affect the total logistics costs. Shorter production processing time, and produce optimal solutions. However, the right limits must be carefully defined to get a viable solution.

1. Introducing
Supply chain activities are very influential in all logistics activities that must be seriously reviewed to improve efficiency and optimization in each company. This opens the opportunity for researchers who want to continue to develop the concept of optimization modeling in logistics and supply chain activities. Changes in the global economy have led to widespread use of transportation, which allows continuous supply chain activities. By optimizing supply chain costs from the perspective of a logistics provider, in the optimization model in the form of an integer programmer and entrust it to create low logistics costs that can increase the profits of the company, especially in long distance production.

The purpose of this study is to optimize supply chain costs from the perspective of providing logistics, with an optimization model in the form of an integer programmer. In supply chain planning consisting of resources that include (capacity, flexibility, and costs), then production includes (capacity, flexibility, cost), product (volume), inventory in this case includes (capacity, flexibility, cost, and time ) transportation (costs, modes, time), requests, and a number of means of transportation for each mode are combined in a set of transportation.

2. Metodologi

2.1. Supply chain management (SCM)
Supply Chain Management is a series of companies that work together to create and distribute products or services to end consumers. This series extends from the raw material miner (upstream) to the shop (downstream). The goal to be achieved from each supply chain is nothing but maximizing the overall value produced. An integrated supply chain will increase the overall value of the supply chain.
The moving parts in the supply chain cycle must run quickly with the aim of preventing inventory buildup in one location. So that this flow must be arranged in such a way that the parts in the supply chain cycle move efficiently.

2.2. Integer Linear Programming

- The objective function (Objective Function)
  The objective function is a function that describes the purpose or goal of the integer programming problems relating to setting the optimal resources to achieve optimal results.
- Barrier function (Constraint Function)
  barrier function is mathematically Definition and form of presentation of the available capacity will be allocated optimally to various activities.
- (Decision Variables)
  variables are aspects of the model that can be controlled. The value of decision variables is possible alternatives of linear functions.

In this case the goal is to minimize the total cost of Z. So, the linear programming formula is:

**Purpose function:**

\[
\text{Min } Z = \sum_{j=1}^{n} c_j X_j
\]

**Constraint function:**

\[
\sum_{j=1}^{n} a_{ij} X_j \geq D_i \quad (i = 1, 2, ..., m)
\]

\(X_j\) = the amount of material processed by the method \(j, j = 1, 2, ..., n\)

\(D_i\) = the quantity needed from product \(i, i = 1, 2, ..., m\)

\(a_{ij}\) = contribution of the unit of material which is processed by the product \(j\) method \(i\)

\(c_{ij}\) = unit cost method \(j\)

\(Z\) = total cost

2.3. Research Methods

Product inventory costs are presented in the form of functions (in this approach linear functions of fixed and variable costs). In selecting the location of production, storage, distribution, and things contained in production activities must be identified effectively. However, at the tactical level, aspects such as production and distribution planning, establishing production and transportation capacity, inventory and managing safety inventories are identified. So that in the final activity, at the operational level, the filling and shipping operations are classified.

![Diagram](image)

**Figure 3.1** Supply chain planning process

3. Results and Discussion

Optimization model uses integer programming optimization which is expected to produce efficient optimization solutions. The objective function determines the overall cost of the supply chain planning consisting of four components. The first is the fixed costs associated with the operations of the distributors involved in shipping. The second component determines the cost of supply from the
factory to the distributor. The third component is responsible for the supply costs from the distributor to the final recipient. The final component of the objective function determines the manufacturing cost of the goods produced by the manufacturer.

\[
\begin{align*}
\sum_{c=1}^{D} F_c \cdot T_n_c + \sum_{p=1}^{N} \sum_{c=1}^{D} Q_{c} \cdot H_{o,c,l} + \sum_{c=1}^{D} \sum_{j=1}^{O} H_{o,g,c,j,l} + \sum_{p=1}^{N} \sum_{k=1}^{S} (C_{pk} * \sum_{c=1}^{D} \sum_{l=1}^{Q} X_{p,k,c,l})
\end{align*}
\]  

(3)

**Index:**
- \( c \) : distribution center (\( c = 1 .. D \))
- \( j \) : delivery point / customer / city (\( j = 1 .. O \))
- \( k \) : product type (\( k = 1 .. S \))
- \( l \) : mode of transportation (\( l = 1 .. Q \))
- \( p \) : factory (\( p = 1 .. N \))
- \( N \) : sum of manufactory
- \( O \) : sum of shipping points
- \( D \) : sum of distributors
- \( S \) : sum of types product
- \( Q \) : sum of modes of transportation

**Parameter:**
- \( F_c \) : fixed distributor / center distribution costs \( c (c = 1 .. D) \)
- \( B_k \) : area / volume occupied by the product \( k (k = 1 .. S) \)
- \( V_c \) : The maximum capacity of the distributor / volume \( c (c = 1 .. D) \)
- \( W_{pk} \) : the production capacity for the product \( k (p = 1 .. N) (k = 1 .. S) \)
- \( C_{pk} \) : product costs of the plant \( p (p = 1 .. N) (k = 1 .. S) \)
- \( R_{ck} \) : if a distributor \( c (c = 1 .. D) \) can send the product \( k (k = 1 .. S) \) then \( R_{ck} = 1 \) otherwise \( R_{ck} = 0 \)
- \( T_{P_{ck}} \) : time required for distributor \( c (c = 1 .. D) \) to complete the product \( k (k = 1 .. S) \)
- \( T_{R_{jk}} \) : pruning time delivery to point of shipment / customer \( j (j = 1 .. O) \) of the product \( k (k = 1 .. S) \)
- \( Z_{jk} \) : customer demand / order \( j (j = 1 .. O) \) for the product \( k (k = 1 .. S) \)
- \( Z_{C} \) : the capacity of the transport unit using modes of transport \( l (l = 1 .. Q) \)
- \( U_{C} \) : the capacity of the transport unit using transportation modes \( l (l = 1 .. Q) \)
- \( T_{F_{p}} \) : delivery time from factory \( p \) from distributor \( c \) using transportation mode \( l \) \( (p = 1 .. N) (c = 1 .. D) (l = 1 .. Q) \)
- \( K_{1, p, c, l} \) : variable cost of sending product \( k \) from distributor \( c \) using transportation mode \( l \) \( (p = 1 .. N) (c = 1 .. D) (l = 1 .. Q) (k = 1 .. S) \)
- \( R_{1, p, c, l} \) : if factory \( p \) can send to customer \( c \) use transportation mode \( l \) then \( R_{1, p, c, l} = 1 \) if not \( R_{1, p, c, l} = 0 \) \((p = 1 .. N) (c = 1 .. D) (l = 1 .. Q) \)
- \( A_{p, c, l} \) : fixed cost delivery from the manufacturer \( c \) uses the mode of transportation \( l \) \( (p = 1 .. N) (c = 1 .. D) (l = 1 .. Q) \)
- \( H_{o, c, j, l} \) : shipping cost from distributor \( c \) to customer \( j \) uses the mode of transportation \( l \) \( (l = 1 .. Q) \)
- \( T_{m, c, j, l} \) : the delivery time from distributor \( p \) to customer \( j \) uses the mode of transportation \( l \) \( (l = 1 .. Q) (c = 1 .. D) (j = 1 .. O) \)
- \( K_{2, c, j, l} \) : variable cost of sending product \( c \) from distributor \( c \) to customers \( j \) uses the mode of transportation \( l \) \( (l = 1 .. Q) (c = 1 .. D) (j = 1 .. O) \)
- \( R_{2, c, j, l} \) : if distributor \( c \) can send to customer using transportation mode \( l \) then \( R_{2, c, j, l} = 1 \) if not \( R_{2, c, j, l} = 0 \) \((l = 1 .. Q) (c = 1 .. D) (j = 1 .. O) \)
- \( G_{c, j, l} \) : the fixed cost of shipping from distributor \( c \) to customers \( j \) uses the mode of transportation \( l \) \( (l = 1 .. Q) (c = 1 .. D) (j = 1 .. O) \)
The fixed cost of shipping from distributor $j$ uses transportation mode $l$ ($l = 1..Q$) ($c = 1..D$) ($j = 1..O$)

4. Conclusion

This study presents a model for optimizing supply chain costs, in MILP form by describing the solution using linear programmers. From the perspective of logistics provision activities can optimize access to all participants in the downstream chain.

In this case it is possible to find distribution flows (decision variables) for supply chain models, which minimizes global logistics costs that satisfy customer needs. Furthermore, the analysis presented in this case, only in terms of the capacity available to distributors and the number of transport units fully confirms this statement.

References

[1] Azmi, I., Norlida, A.H., Nasaruddin, H., dan Nik, I. (2017) Logistics and supply chain management: The importance of integration for business processes. *Journal of Emerging Economies and Islamic Research*, 73-80.

[2] Beaman, MB (1998) Supply Chain Design and Analysis Models and Methods. *International Journal of Production Economics*, Volume 55, no. 3, 281-294

[3] Guo, R., and Tan, Q., (2008) An Optimized Supply Chain Planning Model for Manufacture Company Based on JIT. *International Journal of Business and Management*, Volume 3, pp 129-133

[4] Hong, HB, Hong, SB And Lam, LH (2013) Overview of Sustainable Biomass Supply Chain. *Clean Techn Environ Policy*, Volume 18, 2173-2194

[5] Makarova, I., Shubenkova, K. Dan Pashkevich, A. (2017) Logistical Cost Minimazition for Delivery of Shot Lost. *International Journal of Logistical Information System*. Volume 178, 330-339.

[6] Mulia, J., Maheut, J. Dan Garcita, P. (2012) Supply Chain Network Design Optimization. *Journal of Marketing and Operations Management Research*. Volume 1, no.2, 1909-1919

[7] Said, H. Dan Rayes, EK (2014) Automated Multi-Objective Contruction Logistick Optimization System. *International Journal of Logistical Information System*, Volume 43, 110-122.

[8] Speranza, GM (2018) Trends in Transportation and Logistics. *European Journal of Operational Reserch*. Volume 264, ISSU 3, 830-836.

[9] Yadegari E., Hesamaddin N., and Morteza G., (2015) A Flexible Integrated Forward / Reverse Logistics Model with Random Path-based Memetic Algorithm. *Iranian Journal of Management Studie*, Volume 8, pp 287 - 313