Optimization of Supply Chain Strategies to Meet Delivery Goals with ANP, SWOT, and TOPSIS Approaches: A Case Study of the Sugar Refinery Industry

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Abstract

The sugar refinery industry in Indonesia is one of the important sectors of the manufacturing industry. The sugar refinery industry should supply the product to the other industries as the raw material to produce the solid product. According to the industry supply, the sugar refinery industry needs to optimize the strategy to deliver the product to meet customer demand. This research aims to optimize the supply chain management strategy in the sugar refinery industry to meet the delivery targets by using 3PL. The 3PL's transportation network comprises many lanes, each of which connects to a city in another state or province. With hundreds of shipping orders arriving every day, the 3PL can maintain the delivery focus on transportation availability and process to deliver the product as per request from the customer. This study was conducted based on analysis that included surveys and secondary data, which included the plan vs. actual delivery to see the differentiation before and after using the 3PL on the process to improve the delivery goals in the sugar refinery industry. Furthermore, this study uses a combination of an ANP, SWOT analysis, and the TOPSIS method to implement the supply chain strategy in the supply chain department and conducts an evaluation review to identify the best strategy to implement the fulfillment delivery for the sugar refinery industry to optimize and achieve the delivery targets for sugar refinery products in the sugar refinery industry.

Keywords
Supply Chain Management, 3PL, Delivery, Sugar Refinery Industry, ANP, SWOT Analysis, TOPSIS

1. Introduction

Sugar is one of the most highly affected commodities, with the European Union, Japan, and the United States among the biggest violators. However, internal developments in the sugar and sweetener markets in the European Union and the United States and international trade agreements need change and present the finest chance for policy reform in several decades. Reforms can have a wide range of repercussions for developing nations, depending on their type. Higgins, A and Harrison, A (2006), the sugar mills deliver their products to one of seven ports (usually the closest). The sugar harvest season runs from June to November, as this is when the majority of sugar is produced. However, sugar exports are permitted outside of the harvest season, necessitating the construction of vast storage facilities at ports. There are several grades of sugar available to international buyers, and the majority of sugar mills are prepared to create multiple grades, however, no mill can produce all grades.

The scheduling of mills' sugar grades and the allocation of ships to load at ports Producing a timetable is a difficult undertaking owing to the decision-requirement maker's having to consider disparate production prices and capabilities amongst mills; ship arrival dates; port storage capacities; and port berthing capacity, which varies between ports. Additionally, there are some additional specialized factors, such as the lead time required for mills to switch product grades and the capacity of some ports to store multiple grades of sugar. A sugar industry decision-maker will attempt to plan the production of several sugar grades among mills to reduce the total cost of sugar manufacturing. The decision-maker must also schedule the grades of sugar produced at each mill and allocate ships to ports. If a ship is assigned to a port that does not have an adequate supply of the required grade to meet the shipping quota, it must either wait up to three days until the mills produce an adequate quantity of sugar for that grade or visit a second port to meet the quota.

Indonesia has sugar refinery mills located at a distance from the customer mills. This makes the activity of scheduling the trucks from the mills to the ports a difficult task compared to the Indonesian sugar industry. Scheduling tools to assist decision-makers at the milling–marketing interface of an agriculture supply chain are new to the literature, though models at the farm household level are expected—numerous papers in the literature address logistical activities at the port and shipping. Models for port activity scheduling primarily focus on moving containers from trucks to ships. In many sugar enterprises, the transportation system is over-fleeted, with an excessive number of interdependent employees and no formal management structure in place. This leads to a cyclical pattern of supply that fluctuates between vehicle lines at the mills and no-cane stops, which are both damaging to the system. One requires additional trucks, the mill cannot work successfully due to fluctuating cane supplies, and the season must be prolonged. All of these factors limit profitability, and in the majority of situations, a system is required to ensure consistent supply.

Operational efficiency may be quantified using a variety of different measures. Selecting relevant performance measures is a challenge for decision-makers, as various businesses utilize a variety of metrics to reflect their unique objectives, strategies, and rules. To develop a flexible performance assessment model applicable to a variety of industrial supply chains, the objective is to identify a set of generic logistical performance indicators that can be adapted to meet the demands of the individual context or circumstance. The set of KPIs affecting the OR logistics supply chain in this study was chosen based on a complete examination of the literature by Moons et al. (2019) and the knowledge of the OR logistics manager. Moons et al. (2019), analyze internal supply chain performance assessment systems for inventory management and distribution systems and provide a set of performance indicators classified according to four objectives: quality, time, financial, and organizational productivity. The inventory management system improvement projects look promising in terms of producing considerable efficiency improvements while maintaining acceptable patient care service levels. However, inventory control in the OR is complicated by the absence of data on inventory levels, usage, or surgical expenses. Additionally, these statistics are necessary to persuade stakeholders of the financial, clinical, and operational benefits of efficient supply chain procedures. The primary difficulty for industrial logistics management is managing expenses and inventory levels in order to maintain high-quality and just-in-time delivery.

According to Huang and Peng (2003), the ANP is increasingly accepted by decision-makers and has developed into an effective instrument for organizations to make decisions on a variety of complicated challenges. According to the ANP method's nature, it may also be used to determine indicator weights. It is defined by taking into account the current situation and the dependency of each indicator or the interaction of neighboring levels, and then synthesizing the influencing indicators to create their combined weights using the "hypermatrix." Moons et al. (2019) utilized the ANP approach to determine indicator weights and prioritize indicators. As a result, this article incorporates the ANP, SWOT, and TOPSIS techniques to provide a model for supply chain sustainability evaluation.

1.1 Objectives

The service delivery difficulty occurs when service requests are unknown in advance and vehicles travel different routes during their workday. Large-scale examples of the decision issue confronting an urban consolidation center that dynamically takes consumer orders and delivers them in batches for last-mile distribution. The choice issue of picking freight for long-haul round-trip transportation. In this case, freight requirements are discovered progressively over time and must be delivered and picked up at various places. At each place, the traveler must queue with the competitors; the length of the queue is unknown to the traveler prior to arrival, and the wait time is stochastic. Routing issue with irregular service requests using a branch-and-cut technique. The issue emerges in applications such as road maintenance and network monitoring that utilize arc routing. Other kinds of static routing issues using multi-period vehicle plans have been proposed in the literature. Issue of due dates, which requires the fulfillment of customer orders between a release date and a due date, has also been discussed.

2. Literature Review

Integration of supply chains is challenging. Due to the fact that each supply chain member is pursuing its own economic value maximization (the most lucrative return on its efforts), conflicts between their separate objectives are inescapable. For example, transportation operators would like consistent, predictable demand for full loads with broad delivery windows (and a full return load), while supply chain partners emphasize the need to adapt to changing customer needs and wants. Thus, while supply chain integration is a widely recognized goal of effective supply chain management in order to significantly reduce costs and improve service levels (Simchi-Levi et al. 2000), transportation has frequently been managed as a discrete and unrelated activity to meet the needs of partner supply chain functions to meet the delivery targets (fulfillment). As a result, it is suggested here that it has performed below its capacity, resulting in excessive expenditures not just for transport operators, but virtually always for transport consumers, as these additional costs either harm margins or are passed on to customers. According to Dachyar and Novita (2016), supply chain management is a subset of logistics activities that involves the planning, implementing, and controlling the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements.

2.1 Supply Chain Management

A sugar industry is a complex supply chain comprising the following sectors: sugarcane cultivation, cane harvesting, transportation to the mill, mill processing, storage, marketing, and shipping to consumers. The effectiveness and efficiency of delivery are defined not only by the manner in which the various planning tasks are addressed but also by their interaction. Planning methodologies are appropriate only if they are compatible with the application's internal and external properties. They must be suited to/designed for the features of health care delivery that are distinctive, including: (1) patient engagement in service processes; (2) simultaneity of production and consumption. Collaboration with supply chain partners, rivals, and network relatives is very much "in vogue" in this field right now. For instance, strategic capacity dimensioning decisions place severe constraints on tactical and operational planning and scheduling. Transport providers, in collaboration with inventory and customer service managers, may achieve higher accuracy and dependability at a lower cost through increasing visibility. Supply chain management and logistics are the most often used TOPSIS subjects. Supply chain and logistics management include a number of distinct subfields, such as supplier selection, transportation, and location issues. Chen et al. (2006) developed a fuzzy systematic method to supplier selection, extending TOPSIS to include supplier profitability, relationship proximity, technical capacity, compliance quality, and dispute resolution aspects.

2.2 Logistic Management

Logistics is primarily concerned with the processes that support the physical delivery of items along the supply chain to the final consumer. Logistics, in general, accounts for a significant portion of the logistics expenses in various businesses. According to a Building Research Establishment (BRE) (2003) study, transportation costs account for between 10% and 20% of total construction costs. To do more research into how the construction supply chain's structure and the physical properties of building materials may impact transport capacity, the seven transportation cost factors can be considered. Individual shipments should often be grouped into bigger loads to maximize transportation efficiency.

Customer (i.e., contractor) demand drives this material flow, which includes order processing, inventory management, material handling, packing, warehousing, and transportation operations (Bowersox et al., 2007). Optimizing logistics management in general and transportation efficiency in particular may add value throughout the supply chain and result in considerable cost savings for the construction sector and its consumers. According to the characteristics described above, the transportation cost of construction supplies may account for a disproportionately large amount of logistical expenses. Improved transportation efficiency can result in substantial savings for MS. Cost savings are passed on from suppliers to contractors and, finally, to customers.

2.3 Analytical Network Process (ANP)

The Analytical Network Process (ANP) is the process through which the Analytical Method Hierarchy Process (AHP) is developed. ANP has the potential to enhance structural differences in AHP by allowing for interrelationships between criteria or alternatives. The ANP approach is more complicated than the AHP method (Saaty, 1998). Weighting using ANP necessitates the development of a model that captures the connections between the criteria and their sub-criteria. According to Saaty (1999), the following processes are required to produce ANP in a few steps. Step 1: Create a problem model and framework. Step 2: The correlation matrix is derived from pairwise comparisons in Step 2. Another kind of control is linkage control, which illustrates the connections between criteria or clusters. The ANP's eigenvalues are computed by comparing the relative importance of each element to the control criterion. Each eigenvalue is calculated by dividing the values of each column in the matrix by the entire row and multiplying by n. The consistency ratio indicates whether or not an expert's evaluations are consistent. The ANP model requires completing three supermatrix levels. The good choice is the one with the greatest global significance. (ii): vector of eigenvalues (weight) I denote a row; j denotes a line, and c denotes a column. "Wij refers to the values contained inside a single row. (j=1, 2,... n)it is a letter. Following the calculation of the maximum lambda, the total number of columns j (j = 1,2,... n) is determined. n: the dimension of the order matrix.

2.4 SWOT Analysis

SWOT analysis is a simple but effective approach to strategic planning that businesses may utilize to ascertain these issues. The internal components of a SWOT analysis are strengths and weaknesses. Analyzing these components requires identifying and analyzing organizational features that may affect the success or failure of an organization's initiatives. If the delivery organization has frequent "failures" (and hence widespread lateness), it may be necessary to extend its vehicle fleet. This supply chain sector requires substantial coordination, and the operation's success is influenced by a variety of internal and external variables. While transportation or supply chain scheduling systems have the most significant overall effect, there are solutions available to aid most transport operations. According to Dayarian and Savelsbergh (2020), it is difficult to guarantee that all requests are fulfilled within the stated time limits in different delivery systems due to the unpredictability of arrivals and the limited size of company vehicles. If the delivery organization has frequent "failures" (and hence widespread lateness), it may be necessary to extend its vehicle fleet. This supply chain sector requires substantial coordination, and the operation's success is influenced by a variety of internal and external variables. While transportation or supply chain scheduling systems have the most impact on the supply chain, there are various options available to aid the bulk of transportation operations.

2.5 The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has shown satisfactory performance in a variety of application areas. Kaya and Kahraman (2011) suggested a modified fuzzy TOPSIS technique for determining the most advantageous energy technology based on technical, economic, environmental, and social variables. Albayrak and Erensal (2009) identified decision-making challenges in knowledge transfer. Rahimi, Gandy, and Mogharreban (2007) implemented a web-based medical diagnostic system. Our contributions are threefold: we developed a categorization system that takes these practical aspects into account. Our contributions are threefold: we developed a categorization system that takes these practical aspects into account; we conducted a structured evaluation of prior research on the TOPSIS technique; and we identified research topics for further inquiry. According to Dachyar and Maharani (2019), TOPSIS used metric distances to quantify the alternatives' positive and negative ideal solutions. The Technique for Order of Preference by Ideal Solution (TOPSIS) approach will be used to determine each supplier's final score, which will be used to segment providers. The ideal solution maximizes benefit and reduces expense, while the ideal solution increases cost and decreases benefit.

3. Methods

This research is based on the examination of primary data (surveys and interviews) and secondary data (websites, academic journals, case studies, research papers, books, and quarterly reports of sugar refinery firms in Indonesia). We conduct a mixed analysis in which qualitative and quantitative data are combined. Surveys and interviews were undertaken to examine logistics difficulties, particularly the supply chain management approach used to satisfy delivery targets set by the firms. The data is then compared to company data such as yearly reports, sales and demand volume, and others that objectively represent strategy and employ the ANP, SWOT, and TOPSIS approaches to determine which method optimizes delivery fulfillment. Following that, the comparative outcome is discussed and assessed qualitatively.

3.1 Analytical Network Process (ANP)

3.2 SWOT

3.3 TOPSIS

This material flow is driven by customer (i.e., contractor) demand, which comprises order processing, inventory management, material handling, packaging, warehousing, and transportation activities (Bowersox et al., 2007). Optimizing logistics management in general and transportation efficiency in particular has the potential to provide value across the supply chain and result in significant cost savings for the construction industry and its customers. Transportation costs for building materials may account for a disproportionately significant share of logistical expenditures based on the features stated above. Increased transportation efficiency has the potential to result in significant savings for MS. Suppliers pass on cost reductions to contractors, who in turn pass them on to consumers.

When picking particular technologies from the entire menu outlined above, it may be beneficial to assess the amount of change necessary to facilitate broader integration of transportation inside supply chains. This will obviously depend on the conditions. Three decision-making categories have been added to facilitate this: structural, inter-functional, and operational. Structural transformation entails the purposeful reconfiguration or redesign of a significant component of the supply chain in order to realize value improvements via improved transportation integration. Both inter-functional enhancements and operational adjustments involve a two-way process of collaboration; win-win results are often critical to the success of such programs. Inter-functional enhancements include adjustments to transportation integration that have been enabled between two supply chain parties (often a material supplier and a customer) that straddle the transport process. Operational modifications are made as a result of cooperation between the transport operator and a close supply chain partner. Each level will be examined in turn, with examples of a variety of activities that might result in improved transportation integration. The purpose of this study is also to develop and solve a mixed-integer programming model for scheduling the integrated operations of sugar mills and the assignment of ships to ports. Two typical metaheuristics are evaluated in order to find a solution to the model that converges quickly enough on a PC to be utilized for online rescheduling. The sugar industry may benefit from the software in the following ways: (1) reduced sugar production costs and improved logistics management for ship berthing; (2) a significant reduction in the labor resources required to plan such schedules, particularly when rescheduling is required due to changes in mill production rates and ship arrival times; and (3) a scenario analysis capability for investing in port storage facilities and capacities for mills manufacturing sugar.

The problem's scope is to ensure that delivery fulfillment objectives are met. The following specific issues are discussed: Each ship is given a transporter (3PL) vehicle to load the sugar. Due to the fact that this mill produces refinery sugar, it is delivered by road or rail to the closest port (defined by set P), where it is stored in a huge storage facility. The remaining warehouses in this sugar refinery industry are all positioned near the closest port and across Java. Up to around five days in advance, a schedule for when the ships (defined by set L) are scheduled to arrive in west java is known, as is the shipment size (which affects the actual ship size) and grade of sugar needed in each shipment. These are often agreed upon throughout the contracting process with foreign consumers. Queensland Sugar Ltd's normal planning horizon is 12 months or K 1/4 365 days (where K is a set of days), which corresponds to one harvesting season. A constraint in allocating a ship to a port is the berthing capacity, since some ports have size restrictions on the ships they can accommodate. This constraint is denoted by P CP, which denotes the set of allowed ports for the ship *lA*L to dock. The availability of the requisite grade of sugar at the port is a 'implicit' restriction for allocating ships to ports. This availability is determined by the mills' grade production schedules, as well as the industry's grade constraints. When Sugar Refinery Industries assigns ships to ports, one significant limitation is the capacity of the port's storage facilities and the trucking availability..

While the formulation is novel, portions of modeling the flow of sugar supplies at ports bear similarities to the production, warehouse, and retailer interfaces in various stochastic industrial supply chains. However, the formulation is unusual due to the assignment of ships to ports, necessitating a totally distinct solution strategy.

Parameter :

c_{ijk} $cost\ of\ mill\ i \in I\ to\ produce\ grade\ j \in J\ on\ day\ k \in K$ s_{pj0} $stock\ of\ grade\ j \in J\ at\ port\ p$
$\in P\ at\ the\ beginning\ of\ the\quad planning\ horizon\ (input)$ z_p $sugar\ storage\ capacity\ at\ port\ p$
$\in P$ b_{lj} $tonnes\ of\ sugar\ of\ grade\ j \in J\ that\ ship\ l$
$\in L\ is\ to\ pick\quad up. This\ assumes\ that\ a\ shipment\ can\ contain\ more\quad than\ one\ grade\ of\ sugar, which\ does\ happen\ in$ a_l p
$\in L\ is\ to\ pick\ up, \ = \sum_{j \in J} b_{lj}$ $extra\ cost\ per\ tonne\ of\ sugar\ if\ a\ shipdocks\ in\ more\quad than\ one\ port\quad g\ extra\ cost\ per\ extr$
$= \{1\ \ if\ mill\ i \in I\ produces\ sugar\ on\ day\ k \in K\ 0\ \ otherwise$ $t_{lk} = \{1\ \ if\ ship\ l$
$\in L\ is\ due\ to\ arrive\ on\ day\ k \in K\ 0\ \ otherwise\quad tonnes\ of\ sugar\ that\ mill\ is\ i$
$\in I\ forecasted\ to\ produce\quad on\ day\ k$
$\in K.\ This\ forecast\ is\ based\ on\ the\ average\ of\quad the\ past\ 5\ years\ of\ production\ information\ for\ each\quad mill.$ h_i $maximu$
$\in I$ $w_{ip} = \{1\ \ if\ mill\ i \in I\ supplies\ port\ p \in P\ 0\ \ otherwise$

It is assumed a mill will supply one port (ie $\sum_{p \in P} w_{ip} = 1$). A

Although there are rare occasions where sugar from a mill will be transported to an alternative port.
Variables
The model decision variables are defined as follows:

$$x_{ijk} \;\; = \{1 \;\; if\ mill\ i \in I\ produces\ grade\ j \in J\ on\ day\ k \in K\ 0 \;\; otherwise \quad y_{lp} \;\; = \{1 \;\; if\ ship\ l \in L\ loads\ at\ port\ p \in P_l\ 0 \;\; otherwise$$

A solution instance may be represented by X, Y where $X = \{x_{ijk} \forall i \in I, j \in J, k \in K\}, Y = \{y_{lp} \forall l \in L, p \in P\}$.
Other model variables whose values are dependent upon the decision variables are defined as follows:

s_{pik} = tonnes of sugar of grade $j \in J$ at port $p \in P$ at the end of day $k \in K$
r_{jp} = tonnes of sugar of grade $j \in J$ that ship $l \in L$ loads at port $p \in P_l$
Constraints
The capacity of the storage facility at each port is

$$\sum_{j \in J} s_{p,jk} \leqslant z_p, \forall k, p$$

Each mill can only produce one grade of sugar per day of operation, which is represented by

$$\sum_{j \in J} x_{ijk} = o_{ik}, \forall i, k$$

Flow of sugar stocks at the storage facility of each port across time periods is represented by

$$s_{pjk} = s_{ppk-1} + \sum_{i \in I} x_{ijk} t_{jk} w_{ip} - \sum_{l \in L} r_{jp} v_{lk}, \forall j, k, p$$

The tonnes of sugar loaded at a port by a ship is constrained by its capacity and whether it loads at that port

$$r_{p^{\cdot\cdot}} \leqslant b_y y_{l_p}, \forall j, l, p$$

The tonnes of sugar that a ship loads across the ports must equal the total tonnes of that shipment

$$\sum_{p \in P_i} r_{jp} = b_{1j}, \forall j, l$$

If a ship needs to load in a second port, a nearby alternative port will usually be selected ($< 500\ km$ away) to finish its quota. It is assumed that the second port will be visited on the same day, though this may not always be possible in practice. The impact on the solution will be negligible due to the very small number of two port loadings. There must be no negative stock at a port

$$s_{pkk} \geqslant 0, \forall p, j, k$$

The limit on the number of sugar grade changes for each mill

$$\sum_{k \in K} \sum_{j \in J} \sum_{m \in J} (x_{j,k} + x_{imk} + 1 - 1) e_{jm} \leqslant h_i, \forall i$$

with parameter:

$$e_{\neq} = \{1 \;\; if\ j \neq m\ 0 \;\; otherwise$$

3.1 Solution Methodology

The problem of assigning ships to ports has two natural neighbor hoods of moves:
(a) Assign a ship to a different port: If $y_{lp} = 1$ then let $y_{lp} = 0, y_{lp'} = 1$ where $p' \in P_l$ is an alternative port.
(b) Swap the port allocation of two ships: If $y_{lp} = 1$ and $y_{l'p'} = 1$ then let $y_{lp} = 0, y_{l'p'} = 0, y_{lp'} = 1, y_{l'p} = 1$, where $p' \in P_l$ and $p \in P_{l'}$.

3.1.1 Algorithm 1

SET $\phi := 0$
PRODUCE an initial solution X, Y of objective function value Z and let $Z' = Z, Z_{best} = Z, X' = X, Y' = Y, X_{best} = X, Y_{best} = Y$.
REPEAT

REPEAT
OBTAIN a sample of moves from both neighbor hoods of X', Y' and let X, Y be the solution of the move in the sample that produced the minimal objective function value Z. Note that a schedule of grades produced by mills needs to be obtained when testing each move in the sample.
IF $Z < Z'$ and the move is not tabu, SET $Z' = Z$,
$X' = X, Y' = Y$
IF $Z < Z_{best}$ SET $Z_{best} = Z, Z' = Z, X' = X, Y' = Y$,
$X_{best} = X, Y_{best} = Y, \phi = 0$
UPDATE the tabu list with the reverse move
ADD 1 to ϕ
UNTIL $\phi = \phi'$
SET $Z' := Z_{best}, X' = X_{best}, Y' = Y_{best}$
UNTIL CPU time > upper limit

3.1.2 Algorithm 2
PRODUCE an initial solution of X, Y with objective Z
SET $Z_{best} = Z, X_{best} = X, Y_{best} = Y$
SET value of Shake Max
SET $Z' = Z_{best}, X' = X_{best}, Y' = Y_{best}$
REPEAT
SET $\phi := 0$
REPEAT

RANDOMLY select a move from one of the neighbor hoods of X', Y' (probability of pa from neighbourhood a and $1 - pa$ from neighbourhood b) to produce X, Y
IF $Z < Z'$ SET $Z' = Z, X' = X, Y' = Y, \phi = 0$
ADD 1 to ϕ
UNTIL $\phi = \phi'$
IF $Z' \geqslant Z_{best}$ ADD 1 to Shake
IF $Z' < Z_{best}$ SET $Z_{best} = Z', X_{best} = X', Y_{best} = Y'$
IF Shake > Shake Max SET Shake = 1
SET $Z' = Z_{best}$
REPEAT Shake times
RANDOMLY select a move from one of the neighbourhoods of X', Y' (probability of pa from neighbourhood a and $1 - pa$ from neighbourhood b) to produce X, Y
SET $Z' = Z, X' = X, Y' = Y$
END REPEAT
UNTIL CPU time > upper limit

3.1.3 Algorithm 3
Define ld_i as the last date where mill i has been scheduled production of a sugar grade. FOR each port p :
FOR each ship l scheduled to use berth in port $p\left(y_{lp} = 1\right)$:
FOR each grade j that ship l is to load
IF $s_{pjk} < r_{jlp}$ where $v_{lk} = 1$ THEN
REPEAT (Allocate production of the sugar grade to the mills supplying port p) PICK the least expensive mill i in terms of c_{ijk} where $i \in w_{ip}$ and $ld_i <$ due date k.
SET $x_{ijk'} = 1$ for $ld_i < k' \leqslant k$ or until $s_{pjk'} > r_{jlp}$
UPDATE $s_{pjk'}$ for all $ld_i < k' \leqslant k$
SET $ld_i = k'$
UNTIL $s_{pjk} > r_{jlp}$
IF $s_{pjk} > r_{jlp}$ THEN mark ship l at port p as quota not met
IF the sugar at port p storage reaches its capacity then the solution is infeasible

ENDIF
ENDFOR
ENDFOR
ENDFOR
FOR each ship l assigned to port p and marked as quota not met
PICK the closest port p' to p that has enough sugar for the remainder of the quota
IF there is no eligible second port available, then the solution is declared infeasible.
ENDFOR

4. Data Collection

Scheduling tools to aid decision-makers at the milling–marketing interface of an agricultural supply chain is new to the literature. However, farm household models are expected—numerous studies in the literature cover logistical operations at the port and shipping. Scheduling models for port activities are largely concerned with the movement of containers from trucks to ships (Kozan, 2000; Gambardella et al., 2001; Hartmann, 2004). Models for ship berth planning are based on the schedules of operations performed by a ship while in port (Brown et al., 1994) or on berthing locations within a big port (Part and Kim, 2002). While supply chain integration is not new in sugar production, the majority of study has concentrated on the harvesting and transportation interfaces (Milan et al., 2003; Higgins et al., 2004). The Table 1 describes the delivery fulfillment values of a sugar refinery industry in the year 2020.

Table 1. Delivery fulfillment chart of Sugar Refinery Industry 2020

Yearly Target 2020					
MONTH	PLAN	ACT GKR	ACT MOLLASSES	BALANCE	ACHIEVEMENT
Jan-2020	21.137,60	17.384,90	0,00	-3.752,70	82%
Feb-2020	26.430,00	18.553,60	789,20	-7.087,20	73%
Mar-2020	33.758,20	26.074,90	883,00	-6.800,30	80%
Apr-2020	26.617,00	20.900,78	876,00	-4.840,22	82%
Mei-2020	26.907,12	23.904,02	873,22	-2.129,88	92%
Jun-2020	16.064,25	16.259,75	782,00	977,50	106%
Jul-2020	13.798,15	12.624,25	901,00	-272,90	98%
Agu-2020	22.854,70	22.586,70	367,00	99,00	100%
Sep-2020	28.190,25	28.443,35	908,00	1.161,10	104%
Okt-2020	25.560,25	21.092,90	976,00	-3.491,35	86%
Nov-2020	30.859,30	26.367,90	1.270,87	-3.220,53	90%
Des-2020	13.408,10	6.735,15	1.187,00	-5.485,95	59%
Total	285.584,92	240.928,20	9.813,29	-34.843,43	88%

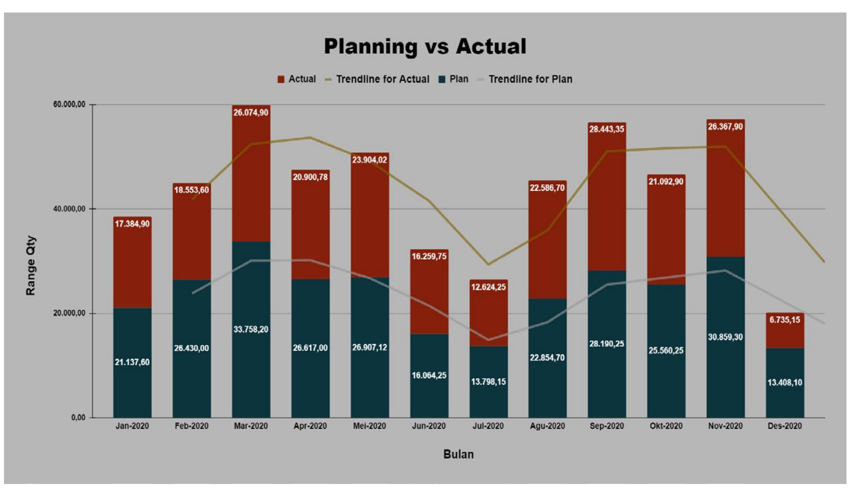

Figure 1. Delivery fulfillment chart of Sugar Refinery Industry 2020

The Figure 1 depicts the Planning versus Actual numbers of a sugar refinery industry in the year 2020.

The Table 2 explains the Percentage of problems which was reported in sugar refinery delivery in 2020.

Table 2. Problem report Sugar Refinery Delivery in 2020

2020 Delivery Fulfillment Issue	Total	Percentage
Trucking Issue	437	34
Schedule Revision	254	20
PO Adminitrative issue	179	14
Sugar Stock	312	25
Trucking Capacity	89	7
Others	0	-
JUMLAH	1271	100

The Table 3 explains the SWOT analysis which was conducted in sugar refinery.

Table 3. Elements of SWOT analysis

Internal factors	
Strengths (+)	Weaknesses (-)
1. Modern trucks and the ability to respond to all requests 2. Worker motivation 3. Professional employees and years of experience 4. Offices in EU and organization and responsibility (family business) 5. Recognition by brand 6. Cost optimization	1. Disloyalty of employee s 2. Workers' omissions (information of exponents, etc.) 3. Close relationship in communication between owner and worker 4. Cost optimization 5. Absence of test moves (employee evaluations) 6. Need for one administrative worker
External factors	
Opportunities (+)	Threats (-)
1. Expanding business 2. Infrastructure growth 3. Association 4. Funds 5. Training course through Eco trainings	1. Closing other companies 2. Growth of levies 3. Unexpected problems from the ground 4. Unloyal competition 5. Indonesian restrictions 6. Fluctuation of labor

5. Results and Discussion

The Table 4 shows the yearly target which was achieved by the sugar refinery industry in year 2021.

Table 4. Delivery fulfillment chart of Sugar Refinery Industry 2021

Yearly Target 2021					
MONTH	PLAN	ACT GKR	ACT MOLLASSES	BALANCE	ACHIEVEMENT
Jan-2021	8.595,00	3.847,90	0,00	-4.747,10	45%
Feb-2021	22.604,00	20.770,35	950,82	-882,83	96%
Mar-2021	18.500,00	25.849,55	923,21	8.272,76	145%
Apr-2021	27.000,00	24.392,50	989,68	-1.617,82	94%
Mei-2021	16.500,00	18.997,55	873,22	3.370,77	120%
Jun-2021	19.800,00	24.264,20	1.062,64	5.526,84	128%
Jul-2021	21.025,00	15.731,00	774,62	-4.519,38	79%
Agu-2021	27.700,00	13.493,70	344,28	-13.862,02	50%
Sep-2021	27.500,00	24.997,25	861,32	-1.641,43	94%
Okt-2021	27.816,43	25.583,55	1.044,10	-1.188,78	96%
Nov-2021	28.000,00	29.851,55	1.162,68	3.014,23	111%
Des-2021	26.775,00	29.633,95	1.392,84	4.251,79	116%
Total	271.815,43	257.413,05	10.379,41	-4.022,97	99%

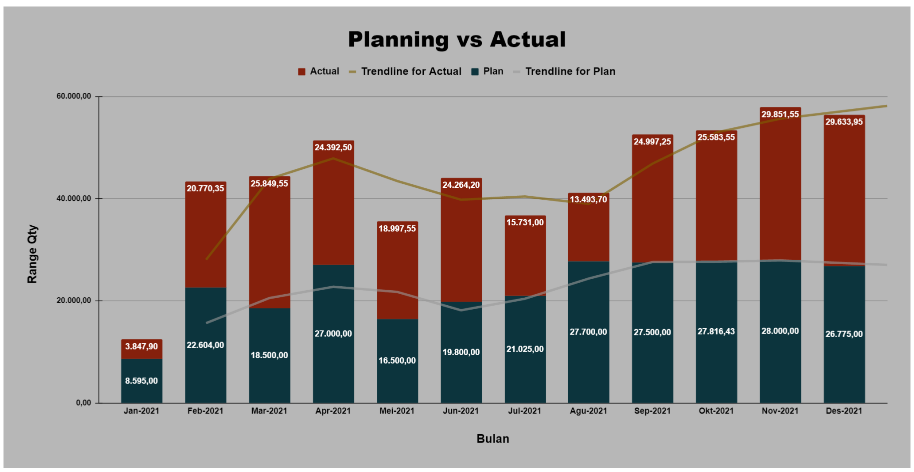

Figure 2. Delivery fulfillment chart of Sugar Refinery Industry 2021

The Figure 2 explains the trend line for the Planning versus Actual in sugar refinery industry in 2021. The Table 5 reports the delivery fulfillment issue percentage reported in sugar refinery delivery in 2021.

Table 5. Problem report Sugar Refinery Delivery in 2021

2021 Delivery Fulfillment Issue	Total	Percentage
Trucking Issue	112	11
Schedule Revision	522	49
PO Adminitrative issue	245	23
Sugar Stock	175	17
Trucking Capacity	-	-
Others	4	0
JUMLAH	1.058	100

The Table 6 contains the problem reported during sugar refinery delivery in 2021.

Table 6. Problem report Sugar Refinery Delivery in 2021

Period (2021)	Transcript: Arrival Documents (Late)	Transporter	Area	Root Cause Issue (Note)
01 Jan - 30 Jun	187	CGL (Single Transporter)	Jabodetabek	Late unloading from the customer
	63		West Java	Late unloading from the customer
	394		Sumatra, Kalimantan (Others)	Shipment issue on the ship
	94		East Java	Flood issue and late unloading from the customer
	67		Banten Province	Late unloading from the customer
	177		Central Java	Documents issue
	142		Export	Documents review from customer
Outstanding (Late Arrival)	1124			
01 Jul - 31 Dec	128	CGL (Single Transporter)	Jabodetabek	Documents issue
	98		West Java	Late unloading from the customer
	76		Sumatra, Kalimantan (Others)	Late unloading from the customer
	26		East Java	Documents issue
	58		Banten Province	Trucking issue
	103		Central Java	Flood issue and late unloading from the customer
	116		Export	Documents issue
Outstanding (Late Arrival)	605			
Outstanding All Period Total	1729			

6. Conclusion

This paper is the first to implement an ANP, SWOT, and TOPSIS hybrid model to identify and evaluate the criteria for an RL outsourcing decision. The social commerce platform as an important support system for reverse logistics should be a strategic goal for businesses. To adapt to the reverse logistics market environment, it is imperative to conduct research on the social commerce network and highly integrated social commerce platforms. It may not be suitable to produce and solve a single model that represents the wider issues at the milling–marketing interface. This is due to increased complexity from incorporating more issues (not all of them fully tangible) within the supply chain while trying to maintain practical relevance for industry decision-makers. Multi-agent modeling is one methodology being considered for capturing the broader supply chain issues while maintaining acceptance and ownership by the decision-maker. The decision to choose a single transporter to use for logistic management is quite successful because it enables the management to maintain the communication and coordination between companies and transporters more intensely by evaluating issues and taking corrective action while the daily delivery is still ongoing.

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Biography

Ayu Mandasari Nasution. is a master's degree student in the Industrial Engineering department at Universitas Indonesia, concentrating in Industrial Management. She completed her bachelor's degree at Universitas Brawijaya, Indonesia, majoring in Fisheries Product Technology, Faculty of Fisheries and Marine Science. She's experienced PPIC (Production Planning and Inventory Control) for over four years in the FMCG Industry which is, her first experience was in the coconut milk and pineapple Industry for over a year. She continued her career in sugar refinery companies in Indonesia till present as a PPIC & Logistic Section Head part of Supply Chain Management Department.

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