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Contract Model in Sustainable Supply Chain Risk Management: An Empirical Evidence on Apple Based Products in Indonesian Small Scale Industry

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Abstract
This research aimed to develop a performance based contract model for supply chain risk management based on revenue sharing and with a goal programming approach. The research was conducted on the famous apple juice industry in Batu City, Indonesia in July-August 2020. Data were collected from several informants namely farmers, collectors and apple juice processor. This research shows that collectors play an important role in the sustainability of the supply chain for the apple juice industry. Collector also gets the largest revenue sharing which of course has been agreed upon by the actors in the supply chain and generates fairly fair revenue sharing.
Keywords: revenue sharing; sustainable supply chain; risk management; apple juice
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1. Introduction

Issues related to sustainability currently cause the food supply chain to expand its objectives leading to a triple bottom line approach rather than economic goals (Gómez et al., 2018). Meanwhile Naik & Suresh (2018) state that the main issues in the sustainable development is ensure the involvement of producers and smallholders in network sourcing as well as in institutional initiatives that help them to meet stringent food safety and quality regulations. Thus, companies can play an important role in creating a sustainable agribusiness chain.

The supply chain is a complex system, consist of several entities, streams, and actors with conflicting perspectives and goals (Mota et al., 2017). Consumers increasingly want to be informed about food safety, the origin and sustainability of the process of creating a product and its delivery (Manning, 2018). The unsustainable supply chain of apple-based food products in Batu City, Indonesia especially apple juice products, is due to several obstacles. These constraints include the SMEs processed apples still depending on middlemen in obtaining raw materials, so that the price of raw materials received by SMEs is much higher than the price of apples at the farmer level (Rayesa et al., 2019).

While supply chain risk management is a large and growing research area, risk management is becoming even more important for agriculture product supply chains due to challenges associated with seasonality, supply spikes, long supply lead-times, and perishable product characteristics (Behzadi et al., 2018). Meanwhile, the risks that arise in the supply chain are related to the sustainability of the supply of apples in Batu City, namely the limited and unsustainable supply of apples as raw material, causing the purchase price of apples to be expensive, especially apples obtained from outside Batu City, Indonesia. In addition, there is no partnership between farmers and apple farmer groups with MSMEs to ensure the sustainability of apple processed production (Rayesa et al., 2019).

While some studies focus on evaluating risk management strategies to select sustainable ones using multi-criteria analysis, most of these studies do not always integrate with uncertainty variables that can lead to biased decision making (Edjossan et al., 2020). With the problem of apple juice producers facing the uncertainty of apple prices, it is necessary to manage apple supply chain risk, namely a partnership system between suppliers of apple raw materials and apple juice SMEs by applying a performance-based contracting (PBC) model based on revenue sharing. Thus, it is hoped that the supply of raw materials for apples will be sustainable.

One of the main problems with contracting is the possible lack of linkage of performance results with supplier inputs and efforts; suppliers are reluctant to be punished for lack of performance for which they are not responsible (Nullmeier et al, 2016). Performance-based contracting has poten to align incentives between buyers and sellers and encourage innovation (Essig et al., 2016). PBC model development based on revenue sharing aims to identify risk variables and parameters, determine performance metrics, determine minimum standards for performance achievement, and determination of bonuses and penalties for actors in the supply chain of apple juice based on the quantity and quality level agreement so that the minimum standard of supplier performance achievement can be identified which can minimize the risk of apple supply chain. Thus, the aim of this study is to develop a performance based contract model for supply chain risk management for apple juice products based on revenue sharing.

2. Research Method

Supply chain profits resulting from profits for each actor with consideration of revenue sharing. Determination of the share of the benefits of coordination between farmer-collectors (supply chain 1) and collector-industry (supply chain 2). Then, supply chain trade-offs 1 and 2 were carried out using a goal programming approach to find the quantity value and revenue sharing for each supply chain actor. The final part is a discussion about the total quantity and distribution of income for each actor.

The research location is Batu City, East Java, Indonesia as an area that has the largest production and center of apple agro-industry in Indonesia. Data collection was done in July-August 2020. The supply chain performance-based contract modeling in the Batu City apple agro-industry was chosen for apple juice products with the consideration that this product has a great potential to develop as a processed product for Batu City's iconic apple and its sustainability is expected to be maintained. The sample of companies chosen is Firm B with the consideration that among SMEs apple juice processing in Batu City, and Firm B is a fairly stable business and produces continuously. Meanwhile, data were collected from each supplier of apple juice product supply chain in Batu City. Data was collected through interviews and Focus Group Discussion (FGD).

The supply chain contract model risk management in this study uses the Performance Based Contract (PBC) approach. The development of this model is useful for identifying risk variables and parameters and determining minimum standards for achieving performance in the supply chain, one of which is distributing profits fairly based on the risks. Supply chain profits resulting from profits for each actor with consideration of revenue sharing. Determination of the share of the benefits of coordination between farmer-collectors (supply chain 1) and collector-industry (supply chain 2). Then, supply chain trade-offs 1 and 2 were carried out using a goal programming approach to find the quantity value and revenue sharing for each supply chain actor. The final part is a discussion about the total quantity and distribution of income for each actor. This study aims to develop a performance based contract model for supply chain risk management based on revenue sharing and with a goal programming approach.

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Revenue Sharing Contract Model

Revenue sharing contract is a model that stipulates that retailers not only pay suppliers based on wholesale prices for each unit of goods, but also share with suppliers a percentage of the retailer's revenue (Cachon and Lariviere, 2005). The revenue sharing contract generated come from a share of revenue, supply chain costs and costs of actors (collector in supply chain 1 and producer in supply chain 2).

$$w_n = \phi_n c_n - c_{n+1} \quad (1)$$

w_n : Revenue sharing contracts in the supply chain n
ϕ_n : Share of revenue in actor n
C_n : Cost of products in chain supply n
C_{n+1} : Cost of products in chain supply n+1

Supply Chain Profit Model

Supply chain profit resulting from total profit on actor n + total profit on actor n + 1, or in other words, supply chain profit is the deviation between revenue and cost and revenue sharing contracts for quantity q (Yang & Chiang, 2008). The formula for the supply chain profits is defined as follows:

$$\Pi_{n(q.p)} = \pi_{n(p.q)} + \pi_{n+1(p.q)} = R_{n(p.q)} - (C_n - w_n)q_n \quad (2)$$

Π_n : Supply chain profits
π_n : Supply chain profits for n actors in supply chain n
π_{n+1} : Supply chain profits for n + 1 actors in supply chain n + 1
R_n : Total revenue in the supply chain n
C_n : The cost of products sold in the supply chain n
w_n : Revenue sharing contracts in the supply chain n
q_n : The quantity of products sold in the supply chain n
p : Price of apple products

Goal Programming

The goal programming model is able to solve linear programming problems that have more than the target to be

achieved. In this study using the priority method approach (Taha, 2007), to find satisfied objectives. The priority method determines the objective function which is formed as representing the objective of the problem. The goal programming formulation is as follows:
Objective function:

$$Minimize = \sum_{i=1}^{n} P_i d_i^- - P_i d_i^+ \quad (3)$$

Goal Constraint:

$$\sum ax_n + d_n^- - d_n^+ = b \quad (4)$$

Resource Constraint

$$\sum ax_n \geq b \; or \; \sum ax_n \leq b \quad (5)$$

Where,
d_i^- and d_i^+ are referred to as deviational variables
P_i is preemptive priority designation for the goal
$x_1, x_2, \ldots, x_n \geq 0$
Based on objective constraints and resource constraints. The objective constraint is to determine the share of revenue and the amount of product between farmer-collectors and industrial-collectors. Constraints to profit, margin and revenue targets. The objective is formulated to find the target revenue share and the minimum product target with the constraints in the apple juice industry.

3. Results and Discussions

Demand and supply in the apple juice supply chain starts from consumer demand. The demand and supply decision in the supply chain begin by forecasting the demand for the coming period. Consumer demand becomes a consideration for apple juice processors to place orders from suppliers, in this case, collectors. If the demand increases, then processor will consider increasing the capacity which also increases requirements for raw materials. However, if demand decreases, processor will consider producing less than the ideal capacity. Unfulfilled consumer demand will affect processors because of reduced service levels or customer service standards.

Currently, the apple-based product chain in Batu City is facing the problem of unsustainable raw material procurement. This problem is caused by the sharing of profits between farmers, collectors and agro-industries that do not meet the expectations and needs of each actor. The unfairness of profit sharing in the supply chain is caused by the largest profit being received by traders / middlemen who have the greatest bargaining power in the supply chain.

This is very regrettable because in fact the biggest risk that exists lies with the first-level actors, namely farmers. In addition, farmers are the key actors in the sustainability of the apple juice supply chain in Batu City. Without an adequate supply of apples as raw material, the sustainability of apple juice products is difficult to maintain. Based on this explanation, a performance contract between each actor in the supply chain is needed to ensure the smooth supply of raw materials in terms of quantity and quality. The steps taken in modeling the performance contract in the supply chain for apple-based products are calculate the cost of each actor in the supply chain, determine the target and actual income for each supply chain actor, establish a revenue sharing model for the interaction of 2 actors, determine the resource constraints of each supply chain actor and calculating revenue sharing. Goal programming formulation to obtain optimal (satisfied) objectives for the quantity of products sold and revenue sharing. The objective constraints in the supply chain are total profit as well as revenue sharing.
The model of revenue sharing contract for apple based product industry as follows:
Objective Function:

$$Minimize\ Z = P_1^1 d_1^- + P_2^1 d_2^- + P_3^1 d_3^- + P_4^1 d_4^- + P_5^1 d_5^- + P_6^1 d_6^- \quad (6)$$

In formulating the objective function, there are several priority objectives expected in this supply chain, namely income, margin, and profit for each supply chain. Thus, the constraint function is as follows.
Subject to

$$(1)\ 3.545.800 = 59.096x_1 + d_1^- - d_1^+ \quad (7)$$
$$(2)\ 450.000 = 7.500x_2 + d2 — d_2^+ \quad (8)$$
$$(3)\ 8.817 = 13.683\Phi_1 + d_3^- - d_3^+ \quad (9)$$
$$(4)\ 41.550 = 7.500\Phi_2 + d_4^- - d_4^+ \quad (10)$$
$$(5)\ 600.000 = 10.000x_1 + d_5^- - d_6^+ \quad (11)$$
$$(6)\ 120.000 = 20.000x_2 + d_6^- - d_6^+ \quad (12)$$

Where,
x_1 : total apples needed by middlemen / collectors;
x_2 : total apples needed by industry.
Φ_1 : revenue sharing for collectors in first supply chain
Φ_2 : revenue sharing for industry in second supply chain
First objective constraints developed based on revenue sharing in supply chain 1 and supply chain 2.

Constraint 1 is for profit target in supply chain 1 (collector);
Constraint 2 is profit target in supply chain 2 (industry);
The revenue sharing contract formulation as second constraint for goal programming used the concept of margin constraints on collectors and industry actors.
Constraint 3 is margin target in supply chain 1 (collector);
Constraint 4 is margin target in supply chain 2 (industry);
The third objective constraint is revenue targets for actors in the supply chain. This profit target was set for farmers and collectors. This is because these two actors are key to the supply of raw materials for the industry. If the revenue target is not achieved as expected, it was feared that the supply of raw materials for the industry will be constrained because suppliers can switch to other agricultural commodities.
Constraint 5 is revenue target in supply chain 1 (collector);
Constraint 6 is revenue target in supply chain 2 (industry).

This model did not include the resource constraints of the two supply chains. This was because the supply of apples as the main commodity as raw material for apple juice is still safe. This is because the industry's need is much smaller than the supply of apples available to farmers and collectors. However, the main obstacle is price. The lower the price of apples at the farmer level, the more likely it is that farmers can switch their farming to other agricultural commodities. Farmers in Bumiaji and Poncokusumo sub-districts have done quite a lot of this, namely switching to citrus commodities because of their more stable prices. In addition, price is also an important indicator for collectors. Thus, the constraints in this model are only focused on income and profits.
The results of data analysis with goal programming on QM for Windows:

Variables	Value
Total requirement of raw material for collector (X1)	60 kgs/day
Total requirement of raw material for industry (X2)	60 kgs/day
Revenue sharing for collector (ϕ1)	64%
Revenue sharing for industry (ϕ1)	18%

The requirement for apples that must be provided by collectors is 60 kg per day, as well as industry which also has to provide 60 kg of apples per day. If the raw material needs are met properly, it will reduce the risk of the supply chain for the apple juice industry from delays in the supply of raw materials. To meet these needs, it is advisable to hold revenue sharing in both supply chains. Revenue sharing obtained by the mediator is 0.64, while for the industry of 0:18. This means, farmers in supply chain 1 get revenue sharing of 36% which shares with collectors. The revenue sharing obtained by farmers and collectors is in accordance with their agreement. Farmers get market guarantees from collectors and collectors also get market guarantees from the apple juice industry.

4. Conclusion

The design of the supply chain risk management performance based contract model results in a revenue sharing based on the share of revenue of 0.64 for collectors from the supply chain 1 and 0.18 for producer in the supply chain 2. In addition to that, needs are obtained raw material for industry and collectors to ensure the sustainability of the apple cider supply chain, namely 60 kg. Thus, the amount of actual raw material supply in this supply chain has been optimal.

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