Risk and value-added balancing model for a sustainable industry’s supply chain

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Abstract. Industry’s supply chain faces obstacles in maintain sustainability, especially in fair profit allocation, increase value added processing and manage risk. The research aimed to formulate risk and value-added balancing model to determine an ideal price in each supply chains stakeholder of sugar industry. Value added was analyzed through Hayami approach while risk was assessed through House of Risk framework. Risk and value added were optimized by using Multi-objective particle swarm optimization (MOPSO) and LINMAP to find an ideal solution of Pareto. A balanced risk and value added was applied to determine an ideal and fair price of supply chain product in each stage stakeholders. The result shows that upstream stakeholders suffer with higher risk while downstream savor major value added and profit. MOPSO algorithm fires well in finding alternative solutions of risk and value-added optimization and LINMAP succeed to find an ideal solution. The research successfully determines the ideal price of product in each stakeholder and distributes profit with considering a balanced risk and value added, product quality, and current product price. For further research, it requires a predicted and sensitivity model to enrich the price scheme of the supply chain.

Keywords: risk model, value-added balancing model, industry’s supply chain

1. Introduction

A business process of an industry must be supported by stakeholders to maintain the production sustainability. A supply chain management offers solutions to coordinate stakeholder in supporting the production sustainability and producing high value-added products for consumers. Some industries have successfully adopted supply chain management, while the rest face serious problems and new challenges. Liu and Papageorgiou [1] reported that the main problem to be solved in industrial supply chain management was a fair profit allocation among stakeholders. A fair profit allocation is a key part in motivating stakeholders to keep producing, avoid internal conflict, and improve sustainability.

Risk and value added were important aspect in supply chain that conflict and affect stakeholders’ profit [2]. Supply chain faced problem in distributing profit among stakeholders that upstream suffer with higher risk while downstream savor profit with high value-added benefit [3]. Value added means an increasing value of a commodity/raw material due to adding input with specific further process that improve the quality and consumer would pay for it [4,5]. A maximum and fair value-added distribution among stakeholders of supply chain may maintains cooperation and business sustainability [2]. On the other hand, risk is internal or external vulnerability that affect the competency of supply chain to produce high value-added product for consumer, decrease the performance and rising problems to achieve supply
chain goals. Every stakeholder in supply chain face different number and dimension of risk and it may affect all supply chain activities.

Risk and value added in supply chain hold important role to maintain cooperation of supply chain. Asrol et al. [6] had proposed a fair risk and value added balancing framework to maintain a fair profit allocation and stakeholders cooperation in supply chain. Many industries faced an unfair profit allocation in balancing risk and value added, as illustrated at the sugar industry that smallholder farmer only achieve 3.4% while distributor may gain 21.4% of profit with lower risk [7]. This condition surely be main threat of the sugar industry’s sustainability; therefore, a risk and value-added balancing is required to maintain supply chain performance, sustainability and achieve win-win solution.

In the research, risk and value-added balancing model involves all supply chain stakeholder to offer a fair price for of sugarcane and sugar in every stage of stakeholders. Set a new reference price as is recommended by the model may improve stakeholder’s profit with considering risk and value added. This model may also assist to determine a fair profit for smallholder farmer and control final product price at the consumer that always be common problems in sugar industry’s supply chain. The important role of a fair and balanced of risk and value added in supply chain management may coordinate a fair profit allocation, determine a fair product price, and maintain the sustainability [2].

Maintaining an efficient and competitive supply chain have been published in many literatures with various focus and problem-solving method. Suharjito and Marimin [8] developed a pricing scheme model with only considering risk of corn supply chain. In other way, Qian et al. [3] proposed a reward sharing to maintain a fair profit allocation in dairy industry’s supply chain. Hidayat et al. [9] developed an agent based modeling with considering investment and risk to distribute profit among supply chain stakeholder. Asrol et al. [2] proposed a fuzzy game theory model with considering risk and value added of each stakeholder to define a fair profit allocation. Further, the research proposed a fair price for each stakeholder based on risk and value-added balancing and optimization.

The research aims to formulate a fair and balanced of risk and value added to obtain a fair price of the sugar industry’s supply chain. To achieve this goal, it requires to analyze supply chain configuration and mechanism, value-added identification and analysis, supply chain risk identification and analysis as the input factor of optimization and balanced model of the risk and value added.

2. Methodology
2.1. Research stages and procedures
Sugar industry in Indonesia is proposed as the research object since it faces many obstacles in efficiency, unfair profit allocation and risk vulnerability along supply chain activities [7,10]. The research is begun with the supply chain configuration and mechanism identification which consist of stakeholders, activities, and roles. Supply chain value added is analysed by Hayami model [11] with specific modification and assumptions for the sugar industry’s supply chain. Supply chain risk is analysed by fuzzy House of Risk framework which has been proposed in [2,12]. A fair and balanced risk and value added is organized in optimization concept to minimize risk and maximize value added of supply chain. A balanced risk and value-added optimization is modelled in Particle Swarm Optimization (PSO) algorithm. An optimize risk and value-added result is applied to determine a fair price of the sugarcane and sugar for each stakeholder. Therefore, an optimal and fair price of each stakeholders is set and performed to maintain a sustainable supply chain. The research stage is depicted at Figure 1.
2.2. Research method and modeling

2.2.1. Value-added analysis

Supply chain value added is analyzed by Hayami concept which also modified by Hidayat [13] and Marimin [13] for plantation and industry’s supply chain. Some modifications and assumptions of the analysis must be defined and for this case are detailed as follow:

- The value added for the smallholder farmer considers sugar content of the sugarcane and sugar bidding price.
- The productivity of the ratoon production of the sugarcane is only considered for 6th level.
- The value-added analysis for all supply chain stage is using 1 Hectare of the sugarcane as the base of calculation.
- To generalize the value-added result for all stakeholder, it is stated in value added ratio as proposed in Asrol et al. [2].
- The general framework of calculating value added in sugarcane supply chain is following the Hayami [11], Hidayat et al. [13] and Asrol [2] models.

2.2.2. Risk identification and assessment model

Supply chain risk is identified and analysis by HOR framework which is proposed by Pujawan and Geraldin [12] and enriched with the fuzzy approach as proposed by Asrol et al. [2]. Supply chain risk is identified for each stakeholder and defined its Aggregate Risk Potential (ARP). ARP is determined by the risk event severity (S), risk agent occurrence (O) and the relation of risk agent and risk occurrence (R). The house of risk framework is described at Table 1 while the mathematical model in determining ARP of stakeholder A (ARP<sub>A</sub>) is stated at the equation 1 and 2.

\[
\text{ARP}_A = \bar{O}_j \sum_i S_i R_{ij} \tag{1}
\]
\[ \mathcal{ARP}_A = \sum_{j=1}^{f} \mathcal{ARP}_j \]  

(2)

Table 1. House of Risk Framework

| Business process | Risk Event (Ei) | Risk Agent (Ai) | Severity of Risk Event I (Si) |
|------------------|----------------|----------------|-------------------------------|
| BP1              | E1, E2, E3     | R_{11}, R_{21} | S_1                           |
| BP2              | E2             | R_{33}         | S_1                           |
| BP3              | E3, E4         | R_{ij}         | S_i                           |

2.2.3. Risk and value-added balancing model for sugar industry’s supply chain

The assumption of the model is that increasing price of a product for a supply chain stakeholder is possible in minimizing the risk, therefore the supply chain risk can be controlled. To define an optimal price for a stakeholder, risk and value added are considered to optimized. In this case, value added is maximized while risk is minimized as multi and conflicted objectives model.

Value added maximization is based on value-added analysis result which known at the previous stage and consider many factors of sugar content, sugarcane delay harvesting and product quality for all supply chain stakeholder. Risk is minimized based on ARP result of the HOR framework and find a permissible risk. To find an optimal and balanced for risk and value added, 3 decision variables are defined, involve number of main raw material (sugarcane) (x), number of additive material (y) and labor (z). All decision variables must meet the search space and found an optimal risk and value added for supply chain stakeholders. The model for maximize value added and minimize risk is described at the Equation 3 – 4, while the search space and constraints are defined at the equation 3 – 17. Since this model should solve 2 objectives Multi – Objective Particle Swarm Optimization (MOPSO) is applied to solve the objective function and find decision variables.

\[
F_1(x, y, z) = \left( x_i + \frac{y_i}{z_i} + f \text{act.} \right) + SC \times RF_i \times P_i - (x_i \times P_2) + (y_i \times P_2) + (z_i \times P_2) 
\]  

(3)

\[
F_2(x, y, z) = (ARP_x \times x_i) + (ARP_y \times y_i) + (ARP_z \times z_i) 
\]  

(4)

Subject to:

\[ i = 1, 2, \ldots, n \text{ (supply chain stakeholder)} \]  

(5)

\[ x, y, z \in \mathbb{R}^N \]  

(6)

\[ F_1(x, y, z) \geq F_1(x, y, z), \forall x, y, z \in \mathbb{R}^N \]  

(7)

\[ F_2(x, y, z) \leq F_2(x, y, z), \forall x, y, z \in \mathbb{R}^N \]  

(8)

\[ SC \text{ (sugar content)} = \text{sugarcontent}_i - (\text{delay}_i \times \text{underquality}) \]  

(9)

\[ \text{Delay} = \text{start}_i + \text{RPT}_i - (\text{arrival}_i + \text{underquality}) \]  

(10)

\[ RF_i \text{ ; for } i \text{ = smallholder farmer} \]  

(11)

if sugar content \leq 6\% then RF_i = 60\%  

(12)

if 6\% \leq \text{sugarcontent} \geq 7\%, then RF_i = 70\%  

(13)

Fact = 0 – 100\% (bad efficiency – efficient well)  

(14)

\[ 800 \leq x \leq 1000 \]  

(15)

\[ 200 \leq y \leq 400 \]  

(16)

\[ 150 \leq z \leq 200 \]  

(17)
2.2.4. Multi-Objective Particle Swarm Optimization modelling

PSO was inspired by the activities of animal group to achieve their goals as finding food. PSO algorithm assumes every individual/particle in a group has position \( x \) and velocity \( v \) and moving in the specific space to achieve goals. Every particle activity may affect other particles activities which finally group can find their goal and optimal solutions. At the initiation stage, PSO algorithm define particle position \( x \) randomly at the \( N \) search space with velocity \( = 0 \). Then, fitness function iteration is completed to find global best \( (X_G) \) and local best \( (X_L) \) in every "Particle = (x_1, x_2, x_3, ... x_N)" and in a specific iteration \( t \).

This result define a new particle’s velocity \( v_i \) and position \( x_i \) as define at the equation 18 and 19 respectively.

\[
V_i(t) = V_i(t-1) + c_1r_1(X_iL - X_i(t-1)) + c_2r_2(X_G - X_i(t-1)) \tag{18}
\]
\[
X_i(t) = V_i(t) + X_i(t-1) \tag{19}
\]

Multi-objective PSO (MOPSO) is set to solve this problem in minimize risk and maximize value added. MOPSO algorithm combines pareto non dominated solution and PSO algorithm to find optimal solution alternatives [14]. Global best \( (X_G) \) and local best \( (X_L) \) parameters are sorted as non-dominated search (pareto) principal to compare optimal solution based on objective function. MOPSO algorithm is categorized as supervised algorithm, therefore it require learning factor \( c_1 \) and \( c_2 \), while \( r_1 \) and \( r_2 \) are random vector [15].

An optimal solution for a balanced value-added and risk optimization is solved using MOPSO algorithm as proposed by Mustaghim and Teich [16]. Finding velocity and position of particle for the MOPSO has same formula with the standard PSO algorithm as defined at the Equation 18 and 19. Moreover, MOPSO requires parameter was inertia weight to control particle’s velocity and the history of previous particle’s velocity which organizing a convergence rate in finding solution efficiently. To determine \( w \) parameter, equation 20 show the formula. Further, parameters of the model in finding an optimal solution for this case are shown at the Table 2.

\[
w_i = \frac{w_{max} - w_{min}}{iteration_{max}} \times iteration_i \tag{20}
\]

| Number of decision variables | Maximum iterations | Number of populations | Number of archives | C_1 | C_2 |
|----------------------------|-------------------|----------------------|-------------------|-----|-----|
| 3                          | 100               | 500                  | 100               | 1   | 2   |

MOPSO algorithm recommends many optimal solutions alternative and are mapped into Pareto front. All the alternative solutions fulfill in minimize risk and maximize value added with considering constraints and decision variables. Therefore, to find an ideal solution, LINMAP (Linear Programming Technique for Multidimensional Analysis Preference) algorithm is applied. An optimal solution of pareto front \( (F_{ij}) \) is determined by the solution which has lowest LINMAP value and has Euclidian distance to optimal pareto front \( (F_{ij}^{ideal}) \). Mathematically, an ideal solution using LINMAP \( (D_i) \) is defined at the equation 21.

\[
D_i = \sqrt{n \sum_{j=1}^{n} (F_{ij} - F_{ij}^{ideal})^2} \tag{21}
\]
2.2.5. Determining an ideal price for sugar industry’s supply chain

Optimization result of a balanced risk and value added which is solved by MOPSO is used for the pricing model scheme. A balanced risk and value-added model assume that the highest value added and profit of a stakeholder may minimize risk vulnerability therefore risk and value added are balanced. To apply this objective, set a pricing scheme of each stakeholder is the empirical solution to allocate higher price for the stakeholder with has highest risk. Set a price with considering a balanced risk and value added is modeled into a linear model using selling price of each product in every stage of the stakeholder ($F_P$).

A price is set as the fix price and incentive based on risk and value-added performance. A fix price is found by average price using historical data of the current condition while incentives are involve value added result of MOPSO model ($F_1$), quality of the product ($Q$) and stakeholder risk value as the result of the MOPSO ($F_2$). Therefore, pricing model with consider a balanced risk and value-added for each stakeholder stage in sugar industry’s supply chain is shown at the equation 22.

$$ OP_i = F_P + ((F_1 \times F_P) + (Q \times F_P)) - (F_2 \times F_P) $$

(22)

3. Result and discussion

3.1. Sugar industry’s supply chain configuration

A sugar industry’s supply chain needs smallholder farmer and distributor to ensure the business process sustainability. The production process of the sugar industry’s supply chain is started with ensuring raw materials availability from the farmers plantation then sugar storage at the warehouse. Commonly in Indonesia, the availability of raw materials is fulfilled by the industry’s own plantation or smallholder farmers plantations. Sugar mills produce sugar product through specific and complex processes to consumed by the final consumer. Distributors has a role to distributes sugar of the sugar mill products to the other small distributor, retail or directed to final consumer. The mechanism of the sugar industry supply chain and stakeholders’ activities are depicted at the Figure 2.

![Figure 2. Supply Chain Configuration and Activities of Sugar Industry](image-url)
The supply chain analysis is completed with the push/pull cycle process identification. At the pull process, the supply chain activities are triggered by the customer order while push process is initiated to make to stock. Smallholder farmers and sugar mill is categorized as push system which are doing activities for providing buffering stock and anticipated demand while distributor has pull system which is initiated by the consumer demand. The pull and push system determine the business process activities of stakeholder.

3.2. Supply chain value added analysis
The value added in sugar industry’s supply chain is analyzed at the smallholder farmer and sugar mill. Value added is calculated through profit achievement for each stakeholder and any cost to be earned. In this case, smallholder farmer and sugar mill are analyzed the value added while distributor is only projected by the result of sugar mill value added because it is not doing specific transformation process and value adding activities and the information is dominantly adopted by pricing at the market. The value-added analysis is essential to know for maintaining the competitive advantage.

Modified Hayami method with some assumptions are applied to analyze the value added for the smallholder farmer. As the result the value-added calculation for the smallholder farmer is shown at the Table 3. Value added ratio is stated to generalize the value-added performance which shown 15.70 % for the smallholder farmer. Further, using same formula and assumptions, the value added for the sugar mill reach 40.75%.

The value-added analysis for smallholder farmer and sugar mill also important to understand the profit distribution among supply chain stakeholders which proposed in the research.

| Table 3. Smallholder Farmer Value Added |
|-------------------------------|-----------------|-------|
| No | Variable | Unit | Value |
|---|---------|------|-------|
| Supply chain interactions | | | |
| 1 | Sugarcane seed price | Rp/Ku | 70 000 |
| 2 | Sugar bidding price | Rp/Ku | 1 250 000 |
| 3 | Total sugar content value | % | 7.00% |
| | Sugar content for smallholder | % | 4.62% |
| 4 | Sugarcane price for farmer | Rp/Ku | 57 750.00 |
| | Molasses price for farmer | Rp/ku | 150 000.00 |
| Output, Input and price | | | |
| 5 | a. Output (Volume of sugarcane) | Ku/Ha | 900 |
| | b. Output (Value) | Rp/Ku | 51 975 000 |
| | c. Output (Price of Molasses) | Rp/Ku | 8 100 000 |
| 6 | Raw material cost | Rp/Ha | 7 000 000 |
| 7 | Adding material cost (Production) | | |
| | a. Land lease | Rp/Ha | 25 000 000 |
| | b. Fertilizer | Rp/Ha | 7 273 750 |
| | c. Irrigation | Rp/Ha | 1 251 000 |
| 8 | Adding cost (operational) | | |
| | a. labor cost for cultivation | Rp/Ha | 1 668 000 |
| | b. labor cost for treatment | Rp/Ha | 5 297 855 |
| | c. Sugarcane transportation | Rp/Ha | 3 150 000 |
| Value added and revenue | | | |
| 9 | a. Value added | Rp | 9 434 395 |
| | b. Value added ratio | % | 15.70% |

3.3. Supply chain risk analysis for sugar industry
Supply chain for sugar industry is analyzed in each supply chain stakeholder, involve smallholder farmer, sugar mill and distributor. The risk to be analyzed involve potential event and agent which has
vulnerability and threatening value-adding process along supply chain activities. In this research, there are 3 main risks to be analyzed which potentially give negative impact for the supply chain involve main raw material availability risk, adding raw material availability risk and labor risk. These risks are analyzed through House of Risk framework and found its Aggregate Risk Potential value for each risk.

According to Gao et al. [17] that there are many uncertainty and imprecise factor in supply chain management, therefore expert based knowledge is required in analysis and assessment. Therefore, the risk assessment is assisted by the expert knowledge to give any assessment of occurrence and severity level of the risk event and agent according to House of Risk framework. The HOR framework is enriched by the fuzzy assessment to overcome the uncertainty and imprecise assessment as proposed in [2]. Finally, following the fuzzy HOR for risk analysis and assessment, the ARP value for stakeholder in 3 major risk are described at Table 4.

As the result of the risk assessment showed that the highest potential risk is located at the smallholder farmers of the sugarcane. For the main raw material availability risk, sugar mill faces highest risk due to scarcity in sugarcane availability and quality, low motivation of smallholder farmer to cultivate sugarcane and distribute to the mill, high competition to another sugar mill that are affecting the unfulfilled of sugar mill capacity. Majorly, distributor face lowest risk potential and vulnerability due to possibility in achieving higher profit in market and price operation scheme. This result also corresponds and supports the previous research [3,8] that mostly in supply chain management, the upstream supply chain stakeholder must fight with the highest potential risk while profit is scarce.

Table 4. ARP Value for Risk Analysis and Assessment of the Sugar Industry’s Supply Chain

| Risk agent                              | Aggregate Risk Potential Stakeholder (ARP) |
|----------------------------------------|-------------------------------------------|
|                                        | Smallholder farmer | Sugar mill | Distributor |
| Main raw material availability risk    | 1,197             | 1,593      | 205         |
| Adding raw material availability risk  | 1,269             | 1,071      | 1,071       |
| Labor availability and cost risk       | 1,008             | 252        | 70          |

3.4. Risk and value-added balancing

3.4.1. Risk and value-added optimization
Risk and value-added optimization are the first stage for balancing risk and value added to determining a fair price for each stakeholder stage of the sugar industry’s supply chain. MOPSO algorithm is applied in maximizing value added and minimizing risk. The proposed model at the Equation 3 - 17 are test and find the feasible solutions. Maximizing value added and minimizing risk value in sugar industry’s supply chain are conflict objectives. MOPSO algorithm find optimal alternatives solution through specific stage to find pareto front solution. Solving the model with subject to constraints using MOPSO algorithm is applied in a computer software and the result is described as the pareto front solutions. The pareto front solution is depicted at the Figure 3.
Figure 3. Pareto Front for Solutions of a Balanced and Optimized Risk and Value-Added

MOPSO algorithm fire well in generate solutions and recommends 100 alternative solutions based on number of archives as determined at the initial formulation. Each archive is fulfilled by the more optimal solution than previous solutions along iteration process. Pareto front showed that at the 1st objective the range of solutions are Rp 9,201,366. 00 – Rp10,316,403 while at the second objective the range of solutions are 222,221 – 324,460. Further, it requires an ideal solution to achieve a balanced value added and risk also find a fair price for all supply chain stakeholder stage.

LINMAP algorithm is applied to find an ideal solution from the alternative solutions of the pareto front. LINMAP find the most ideal solutions with Euclidean distance principal as defined at the Equation 21. MOPSO result with 100 alternative solutions in Pareto front are evaluated and find each Euclidean distance to find an ideal solution. Based on the LINMAP algorithm, solution number 17 of 100 is defined as the ideal solutions of the model. The solution show that the value added is Rp. 10,316,403 while risk is 278,936, 20 for sugarcane industry’s supply chain.

3.4.2. Determine an ideal price considering a balanced risk and value-added solution

A balanced risk and value added in the research is defined as a fair price and revenue of each stakeholder stage. An ideal price of the product is considering risk and value-added optimization as found at the previous stage to find a fair revenue. Besides that, the ideal price for each stakeholder stage is also affected by the product quality. The research proposed that a stakeholder with the high risk and good quality product may achieve higher revenue with an ideal price.

An ideal price for each stage of supply chain stakeholder is determined by current average price and incentives. The incentive is obtained from the risk and value-added balancing result and the product quality of each stage of stakeholders. The risk and value-added balancing result have been obtained from the optimization through MOPSO while product quality of each stakeholder is redefined as commonly found at the Indonesian sugar industries.

For the smallholder farmer which produce sugarcane, the quality is divided into 5 stage of quality A (sugarcane with trash <3%), quality B (trash about 3 – 5 %), quality C (trash > 5%), quality D (trash > 5% and many young sugarcane) and quality E for the burned sugarcane. These level of quality of sugarcane are commonly used at the sugar mill which is checked while the sugarcane is arrive at the mill. The sugar mill and distributor produce sugar product which the quality has been regulated through Indonesian National Standard [18], therefore this research follow the regulation.

The main idea and assumption of the model is pricing scheme with considering risk, value added and quality may improve the profit allocation, distribute profit for the highest risk fairly and will make a balanced risk and value added along supply chains. Determining an ideal price for each stakeholder stage has been defined at the Equation 22, especially for the smallholder farmer and sugar mill. Due to
lack of data, an ideal price of distributor is reflected from the sugar mill fair revenue and is added with 10% of possible profit. The assumption of 10% is obtained from the survey by reference [19]. Therefore, using all data and Equation, an ideal price for each supply chain stakeholder with considering value added, risk and quality for sugar industry is depicted at Figure 4.

For the smallholder farmer and sugar mill, there are price improvement due to model recommendation based on risk and value-added optimization and product quality. Price of each smallholder farmer and the sugar mill has been considered partnership scenario 66%:34%, as the regulation for the Indonesian sugar industry’s [20]. As resulted at the value-added analysis, sugar mill produces higher value-added ratio up to 40.75% makes it worthy to achieve higher price than current. The higher value added ratio and price for the sugar mill also accordance to Yao et al. [21] that a business unit is possible to achieve a fair and higher price due to many inputs and specific processing activities. The research has accommodated a fair price and profit accordance to risk and value-added.

Distributors achieve less price than current price of the sugar product. It is a fair price due to lower risk possibility of the distributor in supply chain as found at the risk assessment result. The current price of the distributor stage is obtained from sugar price at the sugar mill and possible any profit to achieve in average. Even model recommendation determines lower price than the reference price, moreover distributor may achieve a fair revenue. For the consumer, the current price is obtained from the reference price as regulated by the government [22]. The result shows that consumer may get lower price than current price of sugar.

This model recommends setting lowest price due to a balanced risk and value added along supply chain which may avoid double marginalization effect to protecting the consumer with a fair price. Furthermore, this model recommendation also avoids anti profiteering act and taking excessive profit by any stakeholder which makes higher price at the consumer stage.

4. Conclusion and recommendation
Sugar industry’s supply chain is organized by the smallholder farmer, sugar mill, and distributor which are doing specific business processing to fulfill consumer demand. A balanced risk and value-added concept are applied using optimization approach to determine a fair price for all stage of stakeholders. The research has successfully developed a fair and balanced risk and value added using MOPSO and LINMAP. MOPSO fire well to find pareto solutions in maximizing value added and minimize risk in sugar industry’s supply chain. Further, the result of the optimization is applied to define an ideal price with also considering products quality and current price of each stage of stakeholder. The model validation shows the ideal price for sugarcane farmer is IDR 4,747.39, for sugar mill product is IDR 5,764.60 and distributor IDR 10,511.99. The model validation show that an ideal price is achieved, and
a balanced risk and value-added model has enabled to distribute a fair price. This model recommends distributing profit fairly to avoid double marginalization effect and protecting consumer.

The research has considered risk and value added and optimize using a revolutionary algorithm. Value added and risk in this research need in-depth analysis to complete the model. Due to uncertainty factors, for further research also needs a predicting model price and sensitivity analysis to strengthen the model recommendations.

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