Forecasting Data Utilization and Unhulled Rice Supply Chain Efficiency in Rice Mills in Brebes District

Kiki Puspitasari[1,2], Budi Dharmawan[1], Yusmi Nur Wakhidati[1], Novie Andri Setianto[1], Dindy Darmawati Putri[1]
[1]Master of Agribusiness Program, Graduate, Universitas Jenderal Soedirman, Purwokerto, Indonesia
[2]Agency of Agriculture and Food Security, Brebes District, Indonesia
Corresponding email: kiki.puspitasari@mhs.unsoed.ac.id

Abstract

Brebes District is one of the major rice-producing areas in Central Java, where rice milling businesses play an important role in managing the unhulled rice supply chain. Fluctuations in unhulled rice prices, supply availability, inventory, and procurement needs require rice mills to utilize forecasting data to support supply chain management. The objectives of this study are: 1) to analyze the utilization of forecasting data; 2) to analyze the efficiency of the unhulled rice supply chain in rice mills in Brebes District. A quantitative approach was employed involving 100 rice milling units selected using Cluster Random Sampling. Data were collected through a five-point Likert-scale questionnaire and analyzed using descriptive statistics and the Supply Chain Operations Reference (SCOR) framework. The results showed that forecasting data utilization was categorized as high, with a mean score of 3.62. Supply chain efficiency was also categorized as high, with a mean score of 3.65. Based on the SCOR dimensions, Reliability scored 3.66, Responsiveness 3.68, Cost 3.64, and Asset Management 3.63. Responsiveness achieved the highest score, while Asset Management obtained the lowest. These findings indicate that forecasting data utilization and supply chain efficiency are well implemented, although improvements in asset utilization and cost management are still needed.

Keywords: data forecasting; rice milling; SCOR; supply chain efficiency; unhulled rice.

I. INTRODUCTION

Rice is one of the most important food commodities in Indonesia and plays a central role in food security, household consumption, agricultural employment, and the rural economy. The continuity of rice supply, however, depends not only on production at the farm level but also on the ability of downstream actors to manage the flow of unhulled rice from farmers to processing and marketing activities. In this supply chain, rice mills represent an important operational node because they connect the availability of unhulled rice with processing capacity, procurement, inventory management, and distribution. The ability of rice mills to manage these activities is therefore closely related to the continuity and performance of the unhulled rice supply chain. Brebes District in Central Java is an important rice-producing area, making rice milling activities an essential part of the local agricultural economy. Based on data reported in the research, the harvested area of rice in Brebes was approximately 78.81 thousand hectares in 2023, with production reaching 424.36 thousand tons of harvested dry rice equivalent (Gabah Kering Giling/GKG). In 2024, the harvested area decreased to 75,981 hectares, while production reached 421,665 tons. Rice production also exhibits seasonal variation, with the main harvest period occurring around March–April. Such variation implies that the availability of unhulled rice as the main raw material for rice mills is not constant throughout the year. Rice-milling operators consequently need to determine appropriate procurement timing, inventory levels, and processing activities according to expected supply conditions.

Uncertainty in the rice-milling supply chain is also reflected in fluctuations in unhulled rice prices. Monthly data compiled in the research for 2021–2025 show that the price of harvested dry unhulled rice (Gabah Kering Panen/GKP) ranged from IDR 3,790 to IDR

8,265 per kilogram, with an overall mean of IDR 5,867.63 per kilogram and a coefficient of variation of 22.46%. The annual average monthly price increased from IDR 4,141.17 per kilogram in 2021 to IDR 7,053.92 per kilogram in 2023, before decreasing to IDR 6,576.08 per kilogram in 2024 and increasing again to IDR 6,780.17 per kilogram in 2025. These variations indicate that rice mills operate under changing procurement and inventory conditions, in which annual average prices alone may not adequately represent the fluctuations faced by businesses at the monthly operational level. These fluctuations in supply and price create operational challenges for rice mills. Procurement decisions need to consider the expected availability and price of unhulled rice, while inventory decisions need to balance the risk of insufficient raw materials against the cost of holding stocks. Processing schedules must also be adjusted to the availability of raw materials and production capacity, while distribution activities need to respond to market requirements. Therefore, effective supply-chain management requires not only the physical movement of materials but also timely and relevant information to support operational planning. Supply Chain Management (SCM) integrates information, procurement, inventory, production, and distribution activities to ensure that products are available in the appropriate quantity, quality, time, place, and cost.

One approach that can support operational planning under such uncertainty is the utilization of forecasting information. Forecasting enables historical and current data to be transformed into information about possible future conditions. In agricultural supply chains, forecasting has been applied to anticipate commodity prices, production, sales, demand, and supply conditions. Previous studies have examined forecasting of agricultural commodity sales and prices using different approaches, including exponential smoothing and ARIMA. For example, forecasting studies have demonstrated the applicability of statistical models to agricultural commodity prices and rice prices, including the use of ARIMA for rice-price forecasting Butar Butar *et al.* (2025). However, an important distinction needs to be made between forecasting as a prediction model and forecasting as information utilized in operational decision-making. Much of the forecasting literature focuses on model development, prediction accuracy, error measurement, and comparisons among statistical or machine-learning algorithms. Such studies are important for determining the predictive performance of forecasting models. Nevertheless, the availability of a forecasting model or prediction does not necessarily mean that the resulting information is actually incorporated into business decisions. A rice mill may have access to historical price data or predicted supply conditions but continue to determine procurement, inventory, and production activities primarily from experience or informal market information. Therefore, from an operational supply-chain perspective, it is also important to examine whether and to what extent forecasting information is utilized in rice-milling activities.

In this study, forecasting-based data utilization is consequently defined as the use of predictive information to support operational activities rather than as the statistical accuracy of a particular forecasting algorithm. The construct covers the utilization of information related to unhulled rice prices, supply conditions, inventory planning, and procurement planning. This distinction allows the study to address a different aspect of forecasting research: not whether a particular model produces the most accurate prediction, but whether forecasting information is used as part of the operational management of rice mills. The utilization of forecasting information is closely related to the need to manage supply-chain performance. Information concerning expected supply and prices becomes operationally meaningful when it supports activities such as procurement, inventory management, processing, and distribution. Consequently, assessing the condition of the supply chain at the rice-milling level is necessary to understand how effectively these activities are managed. In agricultural commodities, supply-chain performance is particularly important because

production is seasonal and is exposed to fluctuations in supply, prices, demand, and other operational conditions.

Supply-chain performance can be evaluated using different approaches, including marketing margins, farmer's share, production efficiency, and operational performance indicators. However, these approaches do not necessarily capture the multidimensional characteristics of rice-milling supply chains. A rice mill may achieve an acceptable marketing margin while still experiencing problems related to delivery reliability, responsiveness to changes in supply, operating costs, or the utilization of production and inventory assets. A broader operational framework is therefore needed to assess supply-chain performance at the rice-milling level. The Supply Chain Operations Reference (SCOR) framework provides a structured approach for assessing supply-chain performance through operational dimensions. In this study, supply-chain efficiency is assessed through four dimensions: Reliability, Responsiveness, Cost, and Asset Management. Reliability concerns the ability of a rice mill to fulfill supply-chain requirements accurately and consistently. Responsiveness reflects the ability to respond to changes and fulfill operational requirements within an appropriate time. Cost represents the ability to control costs associated with supply-chain activities, while Asset Management concerns the effective utilization of resources and assets involved in supply-chain operations. Thus, the concept of supply-chain efficiency in this study refers to the operational performance of the unhulled rice supply chain rather than solely to marketing margins or farmer's share.

Recent studies demonstrate the relevance of SCOR for evaluating rice supply chains. F. Jannah *et al.* (2025) applied SCOR to a rice-milling business in Situbondo and assessed product, financial, and information flows together with supply-chain performance. Their study identified several operational issues, including uncertainty in unhulled rice supply, delays in delivery information, and supply-chain cost conditions. Similarly, Alam *et al.* (2024) applied the SCOR framework to a rice-milling plant at UD. Sumber Tani and assessed supply-chain performance through the SCOR processes, identifying performance issues related to production, delivery timeliness, quality, maintenance, and logistics. These studies demonstrate the applicability of SCOR to rice-milling supply chains, but empirical evidence at the broader rice-milling-unit level in Brebes remains limited. The existing literature therefore remains relatively fragmented between forecasting studies that emphasize prediction models and accuracy and supply-chain studies that emphasize performance measurement. Forecasting research provides information about possible future conditions, while SCOR-based research provides a framework for assessing supply-chain performance. However, limited empirical research has simultaneously described the utilization of forecasting information and the operational performance of the unhulled rice supply chain at the rice-milling level, particularly in Brebes District. This creates a research gap concerning how forecasting information is utilized within rice-milling operations and how the associated supply-chain performance can be characterized using a multidimensional operational framework.

Addressing this gap is particularly relevant in Brebes because rice mills operate within a context of seasonal variation in unhulled rice availability and substantial fluctuations in unhulled rice prices. Examining forecasting-data utilization alongside supply-chain performance can provide a more operational understanding of how rice mills manage information and supply-chain activities under changing conditions. Accordingly, this study focuses on two complementary aspects: the utilization of forecasting information and the performance of the unhulled rice supply chain at the rice-milling level. Therefore, the objectives of this study are: (1) to analyze the utilization of forecasting data in rice mills in Brebes District; and (2) to analyze the efficiency of the unhulled rice supply chain in rice mills in Brebes District using the Supply Chain Operations Reference (SCOR) framework.

II. METHOD

A. Research Design

This study employed a quantitative descriptive research design using a survey approach. The study was conducted to assess two main aspects at rice-milling units in Brebes District, Indonesia: (1) the utilization of forecasting-based data and (2) unhulled rice supply chain efficiency based on the Supply Chain Operations Reference (SCOR) framework. The quantitative approach was used to obtain measurable information from rice-milling operators through a structured questionnaire, while descriptive analysis was applied to determine the level of each indicator and dimension. The research did not examine the causal relationship between forecasting utilization and supply chain performance; rather, it focused on describing their respective conditions at the rice-milling level. This approach is consistent with the research objectives, which are descriptive in nature. The survey method and quantitative approach were adopted from the research design specified in the research.

B. Population and Sampling

The population consisted of approximately 1,000 rice-milling units distributed across 15 subdistricts in Brebes District, based on data from the Agriculture and Food Security Office of Brebes District in 2026. The population distribution consisted of rice-milling units in Brebes, Jatibarang, Songgom, Wanasari, Bulakamba, Kersana, Tanjung, Losari, Banjarharjo, Ketanggungan, Larangan, Tonjong, Sirampog, Paguyangan, and Bumiayu. The minimum sample size was initially determined using the Slovin formula with a 10% margin of error:

$$n = \frac{N}{1 + Ne^2}$$

Where n is the minimum sample size, N is the population size, and e is the tolerated sampling error. With a population of 1,000 rice-milling units and a 10% error tolerance, the minimum sample was approximately 91 units. To improve representation across the study area, the sample was increased to 100 rice-milling units. The sample was allocated proportionally across the 15 subdistricts according to the number of rice-milling units in each subdistrict. After proportional allocation, rice-milling units within each subdistrict were selected using simple random sampling. Each eligible rice-milling unit was assigned an identification number and randomized using the RAND() function in Microsoft Excel. Units were then selected according to the predetermined number of respondents in each subdistrict. Thus, although the research refers to the procedure as *cluster random sampling*, the operational procedure can be described more precisely in the article as proportionally allocated sampling across subdistricts followed by simple random sampling within each subdistrict.

C. Respondent Criteria

The respondents were the owners or principal managers of rice-milling units because they were considered to have sufficient knowledge and authority concerning procurement, inventory, production, and marketing decisions. The inclusion criteria were: (1) the respondent was the owner or principal manager of the rice mill and had decision-making authority; (2) the rice mill was actively operating in Brebes District during the study; (3) the business had operated for at least two years; (4) the rice mill conducted unhulled rice purchasing, unhulled rice processing, and rice sales; and (5) the respondent understood the operational activities of the business, including procurement, inventory, processing, and marketing. Rice-milling units that only provided custom milling services without managing

unhulled rice procurement and inventory, as well as individuals without operational decision-making authority, were excluded from the sample.

D. Data Sources and Data Collection

Primary Data

Primary data were collected through a structured questionnaire administered to the selected rice-milling respondents. The questionnaire was designed to measure the utilization of forecasting-based data and unhulled rice supply chain performance. A five-point Likert scale was used for the questionnaire :

Table 1. A five-point Likert scale was used for the questionnaire

Score	Response
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Source : Adapted from Sugiyono (2022)

The questionnaire was pretested before the main survey to ensure that the statements were understandable and relevant to the operational conditions of rice-milling businesses.

Secondary Data

Secondary data were obtained from relevant institutional documents and publications, including data from the Agriculture and Food Security Office of Brebes District, Statistics Indonesia (BPS), and relevant scientific publications. Secondary data were used primarily to provide contextual information concerning unhulled rice production, prices, supply conditions, and rice-milling activities. The research specifies the use of primary questionnaire data and supporting secondary data for the research.

E. Research Variables and Measurement

Forecasting-Based Data Utilization

In this study, forecasting-based data utilization refers to the extent to which rice-milling operators use historical data and predictive information to anticipate future conditions and support operational planning. Importantly, forecasting was not measured as the statistical accuracy of an ARIMA, XGBoost, LSTM, or other forecasting model. Instead, it was operationalized as the utilization of predictive information in rice-milling operations. This distinction is important because the objective of the article is to assess how forecasting information is used by rice mills rather than to compare forecasting algorithms. The research explicitly defines forecasting in this manner. The indicators included :

1. Unhulled rice price prediction – the use of information to anticipate future unhulled rice price conditions.
2. Unhulled rice supply prediction – the use of harvest-season and production information to estimate unhulled rice availability.
3. Inventory planning – the use of estimated production and demand requirements to determine the amount of unhulled rice inventory required.
4. Procurement planning based on timing – the use of estimated price and supply conditions to determine when unhulled rice should be purchased.
5. Procurement planning based on quantity – the use of estimated business requirements to determine the quantity of unhulled rice to be purchased.

The questionnaire items were derived from the forecasting-based data indicators developed in the research instrument. For example, respondents were asked whether information on harvest seasons or production was used to estimate unhulled rice availability, whether production requirements were used to determine inventory levels, and whether estimated prices and supply conditions were used to determine procurement timing and quantity.

Unhulled rice Supply Chain Efficiency Based on SCOR

Unhulled rice supply chain efficiency was defined as the ability of rice-milling units to manage the flow of products, information, and financial resources effectively and efficiently. In this study, supply chain efficiency was assessed using the Supply Chain Operations Reference (SCOR) framework. The measurement focused on four SCOR performance dimensions:

1. Reliability
2. Responsiveness
3. Cost
4. Asset Management

These four dimensions were selected because they capture important operational characteristics of rice-milling supply chains, including order fulfillment, speed of response, cost control, and utilization of operational assets. Reliability reflects the ability of the rice mill to fulfill supply-chain requirements consistently in terms of quantity, quality, timing, and order specifications. Responsiveness reflects the speed with which the rice mill responds to changes in unhulled rice availability, customer demand, procurement requirements, and delivery schedules. Cost reflects the ability of the rice mill to control supply-chain-related operational costs, including procurement, processing, labor, transportation, and other supply-chain activities. Asset Management reflects the effectiveness of the rice mill in utilizing and managing resources and operational assets, including inventory, processing capacity, equipment, and working resources. The conceptual definitions of these SCOR attributes are specified in the research framework. All SCOR indicators were measured using the same five-point Likert scale.

F. Data Analysis

Instrument Testing

1. Validity Test

   Item validity was tested using the Pearson Product-Moment correlation in IBM SPSS Statistics. The validity test was conducted during the questionnaire pilot test to determine whether each statement adequately represented the intended construct. An item was considered valid when:

$$r_{count} > r_{table}$$

   and

$$Sig. < 0.05$$

   Items that did not satisfy these criteria were considered for revision or removal before the questionnaire was used for the main survey. This procedure follows the validity-testing procedure specified in the research.

2. Reliability Test
   Reliability was assessed using Cronbach's Alpha in IBM SPSS Statistics. The purpose of the test was to assess the internal consistency of the questionnaire items within each variable. A construct was considered sufficiently reliable when:

$$\alpha \geq 0.70$$

   The reliability criteria adopted in the research were: α ≥ 0.90 = very reliable; 0.80–0.89 = reliable; 0.70–0.79 = sufficiently reliable; 0.60–0.69 = less reliable; and <0.60 = not reliable.

Data Processing

The collected questionnaires were processed sequentially through editing, coding, tabulation, and statistical analysis. First, the questionnaires were checked for completeness and consistency. Second, responses were coded from 1 to 5 according to the Likert scale. Third, the coded data were entered and tabulated using Microsoft Excel. Finally, the dataset was analyzed using IBM SPSS Statistics. Data processing and statistical analysis were therefore conducted using:

- Microsoft Excel for editing, coding, and tabulation;
- IBM SPSS Statistics for instrument testing and descriptive statistical analysis.

The original research also specifies SmartPLS for SEM-PLS analysis, but that procedure is not included in this article because the present manuscript is restricted to the two descriptive objectives of forecasting-based data utilization and SCOR-based supply chain performance.

Descriptive Statistical Analysis

Descriptive statistics were used to determine the level of forecasting-based data utilization and unhulled rice supply chain performance. The analysis included:

- frequency;
- percentage;
- mean;
- standard deviation;
- minimum value; and
- maximum value.

The mean score was used as the primary basis for interpreting the level of each indicator and variable. For each indicator, the mean was calculated as:

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

where:
$\bar{X}$= mean score,
X_i= individual respondent score, and
n= total number of respondents.
Because the questionnaire used a five-point Likert scale, mean scores were interpreted using five categories:

Table 2. Interpretation Criteria for Mean Scores of the Likert Scale

Mean Interval	Interpretation
1.00–1.80	Very Low
1.81–2.60	Low
2.61–3.40	Moderate
3.41–4.20	High
4.21–5.00	Very High

Source: Adapted from Sugiyono (2022)

Analysis of Forecasting-Based Data Utilization

The first research objective was analyzed by calculating the mean score of each forecasting-based data utilization indicator and the overall mean score. The analysis procedure consisted of:

1. calculating the frequency distribution of responses for each questionnaire item;
2. calculating the mean score for each forecasting indicator;
3. calculating the overall mean score of forecasting-based data utilization;
4. classifying each mean according to the five Likert interpretation categories; and
5. comparing the relative scores among indicators to identify stronger and weaker aspects of forecasting utilization.

The resulting score was interpreted as the level of utilization of forecasting information, rather than as forecasting model accuracy. Thus, a high score indicates that rice-milling operators tend to use predictive information in operational planning, but it does not mean that the underlying forecasting model has a high statistical accuracy. This distinction follows the operational definition of forecasting used in the research.

SCOR-Based Unhulled rice Supply Chain Analysis

The second research objective was analyzed using the SCOR framework. The analysis focused on four performance dimensions: Reliability, Responsiveness, Cost, and Asset Management. For each SCOR dimension, the mean score was calculated from its respective questionnaire indicators:

$$SCOR_j = \frac{\sum_{i=1}^{k} X_{ij}}{k}$$

Where $SCOR_j$ represents the mean score of SCOR dimension j, X_{ij} represents the score of indicator i within dimension j, and k represents the number of indicators in the dimension. The overall supply chain performance score was subsequently calculated as:

$$SCOR_{overall} = \frac{R + RS + C + AM}{4}$$

where:

- R = Reliability score,
- RS = Responsiveness score,
- C = Cost score, and
- AM = Asset Management score.

The resulting values were classified using the same five-category Likert interpretation. A higher mean score indicates a more favorable perceived condition of supply chain performance. The SCOR analysis therefore allows the study to identify the strongest and weakest performance dimensions rather than reducing supply chain performance to a single financial or marketing-efficiency measure. The research specifically defines supply-chain

efficiency as performance reflected through reliability, responsiveness, cost control, and asset utilization.

III. RESULTS AND DISCUSSIONS

A. Result

Validity and Reliability of the Research Instrument

1. Validity Test

Validity Test of Forecasting-Based Data Utilization

Validity testing was conducted to determine whether each item in the questionnaire adequately represents the construct of forecasting-based data utilization. In quantitative research, item validity can be assessed by examining the relationship between individual item scores and the total score. Pearson Product Moment correlation is one of the commonly used approaches for testing item validity.

Table 3. Validity Test of Forecasting-Based Data Utilization

Item	Corrected Item-Total Correlation	Criterion	Decision
X1.1	0.728	> 0.30	Valid
X1.2	0.752	> 0.30	Valid
X1.3	0.681	> 0.30	Valid
X1.4	0.671	> 0.30	Valid
X1.5	0.731	> 0.30	Valid
X1.6	0.745	> 0.30	Valid

Source: Primary data, processed by the authors, 2026.

The results show that the Corrected Item-Total Correlation values for the six forecasting-based data utilization items range from 0.671 to 0.752. All values exceed the minimum criterion of 0.30. Therefore, all six items are considered valid and can be retained for further analysis. The highest correlation is observed for X1.2 (0.752), while the lowest is X1.4 (0.671). Nevertheless, the lowest value remains substantially above the minimum criterion, indicating that each item has an adequate relationship with the overall forecasting-based data utilization construct. This result is consistent with the methodological principle that validity testing is intended to establish whether questionnaire items appropriately measure the intended construct. Soesana *et al.* (2023) explain that item validity can be assessed through the correlation between individual item scores and the total instrument score, with Pearson correlation commonly used for this purpose.

Validity Test of Unhulled rice Supply Chain Performance

The validity test was subsequently conducted for the unhulled rice supply chain performance construct, which consists of indicators representing Reliability, Responsiveness, Cost, and Asset Management.

Table 4. Validity Test of Unhulled rice Supply Chain Performance

Item	Corrected Item-Total Correlation	Criterion	Decision
Y1.1	0.771	> 0.30	Valid
Y1.2	0.708	> 0.30	Valid
Y1.3	0.656	> 0.30	Valid
Y2.1	0.725	> 0.30	Valid
Y2.2	0.762	> 0.30	Valid
Y3.1	0.708	> 0.30	Valid
Y3.2	0.716	> 0.30	Valid
Y4.1	0.722	> 0.30	Valid
Y4.2	0.651	> 0.30	Valid
Y4.3	0.769	> 0.30	Valid

Source: Primary data, processed by the authors, 2026.

The results indicate that the Corrected Item-Total Correlation values for the ten unhulled rice supply chain performance items range from 0.651 to 0.771. All values exceed 0.30, indicating that all ten items are valid. The strongest relationship is found in Y1.1 and Y4.3 (0.771 and 0.769, respectively), while Y4.2 (0.651) has the lowest value. Despite being the lowest, Y4.2 remains above the required threshold, indicating that the item still contributes adequately to the measurement of unhulled rice supply chain performance. The findings support the methodological view that valid questionnaire items should demonstrate an adequate relationship with the construct they are intended to measure. Soesana *et al*. (2023) emphasize that validity testing is required to ensure the accuracy and appropriateness of quantitative research instruments.

2. Reliability Test

Reliability Test of Forecasting-Based Data Utilization

After validity testing, reliability testing was conducted to determine the internal consistency of the questionnaire items. Cronbach's Alpha was used as the reliability coefficient. Reliability testing is intended to assess the consistency of respondents' answers and the extent to which an instrument can provide consistent measurement.

Table 5. Reliability Test of Forecasting-Based Data Utilization

Variable	Items	Cronbach's Alpha	Criterion	Interpretation
Forecasting-Based Data Utilization (X1)	6	**0.903**	≥ 0.70	Highly reliable

Source: Primary data, processed by the authors, 2026.

The forecasting-based data utilization construct has a Cronbach's Alpha of 0.903. This value is substantially above the minimum reliability criterion of 0.70, indicating that the six questionnaire items have high internal consistency. The result is also consistent with the methodological discussion in Soesana *et al.* (2023), which demonstrates Cronbach's Alpha as a reliability test and shows that an alpha value above 0.90 indicates a highly consistent instrument. Thus, the six indicators can be considered reliable for measuring the extent to which rice mills utilize forecasting-based information in their operational activities.

Reliability Test of Unhulled rice Supply Chain Performance

The unhulled rice supply chain performance construct produces a Cronbach's Alpha of 0.929, which exceeds the minimum criterion of 0.70 and indicates very high internal consistency among the ten questionnaire items.

Table 6. Reliability Test of Unhulled rice Supply Chain Performance

Variable	Items	Cronbach's Alpha	Criterion	Interpretation
Unhulled rice Supply Chain Performance (Y)	10	**0.929**	≥ 0.70	Highly reliable

Source: Primary data, processed by the authors, 2026.

The unhulled rice supply chain performance construct produces a Cronbach's Alpha of 0.929, which exceeds the minimum criterion of 0.70 and indicates very high internal consistency among the ten questionnaire items. This finding indicates that the items measuring Reliability, Responsiveness, Cost, and Asset Management consistently represent the broader construct of unhulled rice supply chain performance. Therefore, all ten items are retained for subsequent descriptive analysis. The result is methodologically consistent with Soesana *et al.* (2023), which emphasizes that reliability testing is required to establish the consistency of a quantitative research instrument and demonstrates the use of Cronbach's Alpha for this purpose.

Utilization of Forecasting-Based Data

The analysis shows that the utilization of forecasting-based data among rice-milling units in Brebes District was classified as high, with an overall mean score of 3.62 on a five-point Likert scale. The scores of the four indicators were relatively similar, ranging from 3.60 to 3.63.

Table 7. Utilization of forecasting-based data

Indicator	Mean	Category
Unhulled rice price forecasting	3.60	High
Unhulled rice supply forecasting	3.63	High
Inventory planning	3.62	High
Procurement planning	3.63	High
Overall	**3.62**	**High**

Note: The five-point Likert scale was interpreted as follows: 1.00–1.80 = very low; 1.81–2.60 = low; 2.61–3.40 = moderate; 3.41–4.20 = high; and 4.21–5.00 = very high.

The highest scores were observed for unhulled rice supply forecasting and procurement planning, both with a mean of 3.63. Inventory planning followed with a mean of 3.62, while unhulled rice price forecasting had the lowest score of 3.60. Despite these differences, all indicators remained within the high category. The relatively narrow range between the highest and lowest indicators, which was only 0.03 points, indicates that the utilization of forecasting-based information was relatively consistent across the operational activities measured. Thus, forecasting-based information was not concentrated on a single activity but was utilized across supply, procurement, inventory, and price-related planning. The finding indicates that rice-milling managers in Brebes generally utilize predictive information as part of their operational activities. The results are consistent with the operational definition adopted in this study, in which forecasting refers to the utilization of forecasting information rather than the testing of the predictive accuracy of particular algorithms such as ARIMA, XGBoost, or LSTM.

Unhulled rice Supply Chain Performance Based on SCOR

The results of the SCOR-based analysis indicate that the overall performance of the unhulled rice supply chain in rice-milling units in Brebes District was categorized as high, with an overall mean score of 3.65.

Table 8. Unhulled rice supply chain performance based on SCOR

SCOR Dimension	Mean	Category
Reliability	3.66	High
Responsiveness	3.68	High
Cost	3.64	High
Asset Management	3.63	High
Overall	**3.65**	**High**

Note: The five-point Likert scale was interpreted as follows: 1.00–1.80 = very low; 1.81–2.60 = low; 2.61–3.40 = moderate; 3.41–4.20 = high; and 4.21–5.00 = very high.

Among the four SCOR dimensions, Responsiveness recorded the highest mean score of 3.68, followed by Reliability at 3.66, Cost at 3.64, and Asset Management at 3.63. All dimensions were classified as high. The difference between the highest and lowest dimensions was relatively small, amounting to only 0.05 points. This indicates that supply-chain performance was relatively balanced across the four dimensions. At the indicator level, the Reliability dimension ranged from 3.64 to 3.68, Responsiveness from 3.68 to 3.68, Cost from 3.61 to 3.66, and Asset Management from 3.60 to 3.65. The lowest individual indicator was found in Asset Management, with a mean of 3.60, whereas several indicators related to Reliability and Responsiveness achieved scores of 3.68. Overall, the results indicate that the unhulled rice supply chain at the rice-milling level in Brebes District has a relatively good performance across reliability, responsiveness, cost management, and asset management.

B. Discussion

Utilization of Forecasting-Based Data

The utilization of forecasting-based data among rice-milling units in Brebes District obtained an overall mean score of 3.62, categorized as high. The indicator scores were relatively similar, with unhulled rice supply forecasting and procurement planning obtaining the highest scores (3.63), followed by inventory planning (3.62) and unhulled rice price

forecasting (3.60). This finding indicates that forecasting-based information is utilized across several operational activities rather than being limited to a single decision area. The relatively high utilization of forecasting information is relevant to the characteristics of rice milling, where raw-material availability and prices vary over time. Forecasting information can support decisions concerning procurement timing, procurement quantity, and inventory planning. This finding is consistent with Mardi Hardjianto (2021), Siregar *et al.* (2022), and Butar Butar *et al.* (2025), who demonstrated the use of forecasting approaches to anticipate agricultural sales and commodity or rice prices. However, these studies primarily emphasize the generation and accuracy of forecasts, whereas the present study focuses on the utilization of forecasting information in rice-milling operations.

This distinction is important because the availability of predictive information does not necessarily mean that it is incorporated into operational decisions. Cahyati *et al.* (2025) emphasized the increasing use of predictive analytics to support agricultural decision-making, while Awan *et al.* (2021) and Shamim *et al.* (2020) highlighted the importance of transforming analytical information into decision-support insights. Although these studies were conducted in broader organizational contexts, they support the view that the practical value of data depends on its utilization in decision processes. The findings are also consistent with the broader agricultural information perspective discussed by Yusriana & Rachman Jaya (2022) and Miftahul Azis & Suryana (2023), who emphasized the importance of information availability and integration in agricultural and food supply chains. Lokot Muda Harahap *et al.* (2024) similarly highlighted the role of information and technological transformation in improving agribusiness processes. In the present study, the high score of 3.62 suggests that forecasting-related information has become part of operational planning among the surveyed rice mills.

Taken together, these studies indicate that the role of forecasting extends beyond producing prediction outputs toward their utilization in operational planning. The present study contributes to this perspective by showing that forecasting-based information is relatively well utilized at the rice-milling level, particularly for supply and procurement planning. However, because this study is descriptive, the result should be interpreted as a measure of forecasting-data utilization, not as evidence of forecasting accuracy or a causal effect on supply-chain performance.

Unhulled rice Supply Chain Performance Based on SCOR

The overall unhulled rice supply chain performance score was 3.65, categorized as high. The four SCOR dimensions showed relatively similar scores: Responsiveness (3.68), Reliability (3.66), Cost (3.64), and Asset Management (3.63). The small difference between the highest and lowest dimensions indicates that supply-chain performance among the surveyed rice mills was relatively balanced.

Responsiveness obtained the highest score (3.68), indicating that the ability to respond to operational requirements represents a relatively strong aspect of the rice-milling supply chain. This finding is relevant to agricultural supply chains, which are affected by seasonal raw-material availability and changing market requirements. U. M. Jannah & Rahmawati (2020) emphasized the importance of supply-chain planning and responsiveness, while F. Jannah *et al.* (2025) demonstrated the relevance of reliability and responsiveness in assessing rice supply-chain performance using SCOR. The Reliability score of 3.66 also indicates a favorable condition in fulfilling supply-chain requirements. This finding is consistent with SCOR-based studies emphasizing the importance of consistency in supply, quality, production, and delivery. Puspita *et al.* (2022) showed that SCOR can be used to identify performance conditions and specific gaps within supply-chain activities. Similarly, Alam *et al.*

(2024) demonstrated the usefulness of SCOR for evaluating different performance indicators in rice-milling supply chains.

The Cost score of 3.64 remained in the high category but was slightly below Responsiveness and Reliability. Cost management is important because rice mills face fluctuations in procurement prices, transportation costs, processing costs, and inventory-related expenditures. F. Jannah *et al.* (2025) also identified cost as an important aspect of rice supply-chain performance. Asset Management obtained the lowest score (3.63), although it was still categorized as high. Therefore, the result should not be interpreted as poor asset management but as a relatively greater area for improvement compared with the other dimensions. Effective asset management is important for rice mills because inventory, processing equipment, storage capacity, and production resources need to be aligned with seasonal raw-material availability. Alam *et al.* (2024) identified operational issues related to production, delivery, quality, and maintenance in rice-milling supply chains.

The overall finding is consistent with previous SCOR-based research showing that a favorable aggregate supply-chain performance does not necessarily mean that all operational dimensions perform equally. Puspita *et al.* (2022) and Alam *et al.* (2024) demonstrate the usefulness of examining individual dimensions to identify specific operational conditions. In the present study, Responsiveness and Reliability show relatively stronger conditions, whereas Cost and Asset Management have slightly lower scores. Overall, the SCOR results indicate that the unhulled rice supply chain at rice mills in Brebes District is relatively well managed across the four assessed dimensions. The findings also suggest that future operational improvements can focus particularly on cost management and asset utilization while maintaining the relatively favorable conditions of responsiveness and reliability.

IV. CONCLUSION

This study concludes that the utilization of forecasting data and the efficiency of the unhulled rice supply chain in rice mills in Brebes District were both categorized as high, with mean scores of 3.62 and 3.65, respectively. Forecasting data utilization supports operational planning and decision-making, particularly in relation to unhulled rice prices, supply conditions, inventory, and procurement planning, rather than evaluating forecasting algorithm accuracy. Meanwhile, supply-chain efficiency, assessed using the SCOR framework, demonstrated relatively balanced performance across Responsiveness (3.68), Reliability (3.66), Cost (3.64), and Asset Management (3.63). Responsiveness recorded the highest score, while Asset Management obtained the lowest, indicating opportunities to improve the utilization and management of supply-chain assets. These findings provide a descriptive overview of forecasting-data utilization and supply-chain efficiency in rice mills in Brebes District, highlighting the importance of predictive information in supporting operational planning and the improvement of overall supply-chain performance.

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