Research Article

Improve Rice Supply Chain Resilience with the SCOR Model

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Abstract | The impact of El-Niño in 2023, which hit Indonesia, caused a year-long drought, making rice availability in the market quite scarce and significantly increasing rice prices. This indicates an interruption in the rice supply chain that will impact its overall stability and resilience. This research aims to design rice supply chain resilience indicators in Gorontalo, Indonesia. In addition to questionnaires, in-depth interviews and focus group discussions (FGDs) were conducted involving participants such as farmers, traders, agricultural extension workers, BULOG employees, Toko Tani Indonesia Center (TTIC)/ the Indonesian Farmers' Shop Center, and the Department of Agriculture. The collected data were analyzed using the analytic hierarchy process (AHP). The determination of the hierarchy in the design of the rice supply chain resilience indicators uses the Supply Chain Operations Reference (SCOR) model. The priority indicators of the rice supply chain in Gorontalo are as follows: planning in the level of core process supply chain. The resilience parameters prioritized are quality. The performance attributes with the highest priority are flexibility. The performance indicators for the rice supply chain resilience include the order fulfillment cycle, quality standard compliance, cash-to-cash cycle, delivery performance, perfect order fulfillment, inventory days of supply, order flexibility, and order fulfillment lead time. The combination of excellent planning stages, maintaining a product quality in line with quality standards, and flexibility, as well as managing the rice fulfillment and cash-to-cash cycles, will enhance the resilience of the rice supply chain in Gorontalo.

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Introduction

Rice is one of the commodities that is the main source of food for the Indonesian population, especially the people of Gorontalo who consume rice every day (Akbar *et al*., 2023). The supply chain is a network of companies working to create and deliver rice to consumers. A supply chain is a sequence of processes (decision-making and execution) and flows (material, information, and money) that occur in nature and between different stages from production to final consumption involving producers, transporters, service providers, logistics, retailers, and consumers (Indriani *et al*., 2020a).

Supply chain management is an approach used to coordinate and oversee the flow of goods from procurement and storage to the distribution of rice by ensuring precise location tracking, cost efficiency, and optimal production planning. Supply chain management plays a crucial role in enhancing supply chain resilience by leveraging knowledge of the characteristics that can either strengthen or weaken it. Resilience is the capacity of a supply chain to restore normal operational performance within an acceptable timeframe following a distruption. Supply chain resilience encompassed the ability of a system to remain stable, prevent disruptions, adapt, recover to its pre-impact state, and even transform challenges into opportunities for improvement (Gölgeci and Kuivalainen, 2024; Rahman *et al*., 2024). In the supply chain, there are dynamic capabilities and operational capabilities. Dynamic capabilities are the firm's adaptive routines that allow for resource reconfiguration and sustained competitive advantage (Soni *et al*., 2014).

Along with population growth, rice consumption in Gorontalo increases every year. Based on data from the Gorontalo Province Food Service (2024), rice consumption in 2023 was 137,507.66 tons, depicting an increase compared to 2022, which was 136,587 tons. Meanwhile, there has been a decrease in rice production from 137,879 tonnes in 2022 to 130,801.79 tonnes in 2023 (Gorontalo Provincial Agricultural Service, 2024). Population growth, followed by an increase in demand for rice consumption, is a serious challenge for achieving the supply chain resilience. Rice commodity is highly susceptible to the effects of climate change, marked by various hazards, such as decreased productivity, harvest area, and crop yield, caused by increasing air temperatures and changes in rainfall (Schneider and Asch, 2020). A similar situation occurred in Gorontalo, where the El Niño effect led to prolonged drought throughout the year, resulting in a rice shortage in the market and a sharp price increase from IDR 10,000 per kilogram to IDR 14,000–15,000 per kilogram. This increase in rice prices indicates a disruption in the rice supply chain reduces its effectiveness in fulfilling consumer demand and will affect the rice supply chain resilience.

Conducting this research is essential to address disruptions in the rice supply chain by enhancing its resilience. One approach that can be employed is the Supply Chain Operations Reference (SCOR) model. The SCOR model serves as a tool for measuring supply chain performance, improving operational efficiency, and facilitating communication among all involved stakeholders. It is a comprehensive management framework that spans the entire supply chain, from suppliers to end consumers (Marimin and Maghfiroh, 2013; Maghfiroh *et al*., 2023). Rice's resilience can be assessed and evaluated through resilience performance indicators (RPI), which can be regularly measured using various operational-level metrics. The SCOR model focused on five key resilience indicators are flexibility, responsiveness, quality, productivity, and accessibility (Rajagopal, 2016), in meeting consumer needs at the lowest possible cost (Siagian *et al*., 2021). The resilience of the rice supply chain is measured using specific attributes, including reliability, responsiveness, agility, cost, and supply chain assets (Pujawan and Mahendrawathi, 2017; Vorst, 2006; Indriani *et al*., 2019b).

Several supply chain studies that have been conducted are as follows: Food supply chains by Suryaningrat *et al*. (2015), Djuric and Götz (2016), Hu and Feng (2017), Xing *et al*. (2016), Bodendorf *et al*. (2023), Maghfiroh *et al*. (2023), Maulana *et al*. (2023), and Nordhagen *et al*. (2023); supply chain management and policies by Djama *et al*. (2023), Putro *et al*. (2021), Achmad *et al*. (2021), and Perdana *et al*. (2022); supply chain risks by Asir (2018), Borodin *et al*. (2016), and Muchfirodin *et al*. (2015); supply chain flow patterns by Courtonne *et al*. (2015), and Liu *et al*. (2023); supply chain mechanisms by Indriani *et al*. (2019a); supply chain performance by Alsheyadi *et al*. (2024), Dissanayake and Cross (2018), Indriani *et al*. (2019b), Jain *et al*. (2022), Marinagi *et al*. (2015), and Suud *et al*. (2021).

However, previous studies have rarely examined systematically how the resilience of the rice supply chain in facing disruptions such as climate change, distribution issues, and dependency on specific logistics systems contributes to rice price fluctuations in the market. Only a few researchers have explored supply chain resilience, and its application has mostly been limited to the fields of digital business and mining. No studies have yet examined the resilience of the supply chain in the food and agricultural sectors, particularly for rice commodities, on a broader scale.

This limitation highlights a research gap, particularly in understanding the relationship between supply chain resilience and the phenomenon of rising rice prices, rather than viewing it solely as a temporary response to crises. Therefore, there is a need for a study that design indicators for rice supply chain resilience, using the SCOR model attributes in order to formulate strategies for strengthening the national food system in a sustainable manner. The aim of the study is to design indicators for the resilience of the rice supply chain in Gorontalo Province.

Materials and Methods

Research design

This study adopts a positivist (quantitative) approach with a survey research method, which involves interviews with actors in the rice supply chain.

Data collection

The research location was chosen purposefully with the consideration that this area is the rice production center in Gorontalo Province, specifically Bone Bolango Regency and Gorontalo Regency, while Gorontalo City serves as the distribution center. The research take place from May to July 2024. In addition to questionnaires, in-depth interviews and focus group discussions (FGDs) to gain deeper insights into rice supply chain's actors. A total of 4 FGDs were held across the six blocks, with each group comprising 8-12 participants, allowing for the organization of expert information and judgments in selecting the most preferred alternatives. The total number of FGD participants were 40 people. FGDs participants consisted of : farmers, traders, agricultural extension workers, the Head of General Company of Public Logistics Agency (BULOG) Gorontalo along with their staff, the Indonesian Farmers' Shop Center (TTIC) staff, Alfamart store staff, heads of divisions and heads of departments along with their staff from the Bone Bolango Agriculture Office, Gorontalo City Agriculture Office, Provincial Agriculture Office, and the Provincial Food Office of Gorontalo, as well as researchers from the State University of Gorontalo.

Data analysis

The collected data were analyzed using the analytic hierarchy process (AHP). The AHP was employed to gather information on decision-making related to the resilience indicators of the rice supply chain in Gorontalo Province. The AHP analysis is a decision support model developed by Saaty. Graphically, an AHP decision problem can be constructed as a hierarchy. AHP begins with the goal, followed by the first-level criteria, sub-criteria, and, finally, the alternatives. There are three principles in solving problems using explicit logical analysis, namely, hierarchy structuring, priority setting, and logical consistency (Marimin and Maghfiroh, 2013; Setiawan *et al*., 2020). The determination of the hierarchy in the design of the rice supply chain resilience indicators uses the SCOR model.

The supply chain operation reference (SCOR) is a tool used to assess the rice supply chain's performance, particularly in raw material supply and distribution (Indriani *et al*., 2024). SCOR employs several general dimensions for measuring the supply chain performance, including reliability, responsiveness, flexibility, cost, and assets (Indriani *et al*., 2024). It then divide these performance attributes into performance metrics, including perfect order fulfillment, order fulfillment cycle time, upside supply chain flexibility, upside supply chain adaptability, cash-to-cash cycle time, and inventory days of supply (Pujawan and Mahendrawathi, 2017).

The parameters of the supply chain resilience are value addition, quality, and risk. According to Surareungchai *et al*. (2021), the product quality is a fundamental factor in consumer satisfaction when deciding which products to purchase. The activity of quality control aims to maintain and direct the quality of the company's products. Risks can lead to several losses, such as disruptions in the production process, which can result in an inability to meet demand. Value addition is the increase in the value of a commodity due to processing, transportation, or storage in production. Factors that drive the creation of value addition include quality, function, form, place, time, and convenience (Hayami *et al*., 1987).

The performance measurement indicator design consists of the following:
Level 1: Supply chain actors, which include the local government (Agricultural Extension Workers, the Department of Agriculture, the Food Department, and BULOG), rice farmers and mills, university researchers, and the private sector (rice traders and retailers: Alfamart).
Level 2: The SCOR model divides supply chain processes into five core processes: plan, source, make, deliver, and return (Pujawan and Mahendrawathi, 2017). The core supply chain processes, which include

the following:

- Planning, which involves strategic and operational planning, demand forecasting, and inventory management.
- Source, which involves sourcing rice from suppliers, selecting the right suppliers, and managing supplier relationships.
- Make, which covers production operations and rice quality management.
- Deliver, which includes warehouse management, delivery of rice to customers, and managing stock availability in the warehouse.
- Return, which covers managing the return of rice from consumers, rice reprocessing, and after-sales service management.

Level 3: Rice performance parameters, which include value-added, quality, and risk.
Levels 4 and 5: Performance attributes and performance indicators. The RPI encompasses indicators related to flexibility, responsiveness, quality, productivity, and accessibility (Bolstorff and Rosenbaum, 2003).

All variables are structured within a hierarchical model for selecting rice indicators, as shown in Figure 1. To assist and simplify the calculations, the Expert Choice software version 4 is used.

Results and Discussion

Actor elements' role in relation to focus elements

The role of the actor elements in relation to the focus elements in the design of the rice supply chain resilience indicators based on the SCOR model in Gorontalo Province is presented in Figure 2.

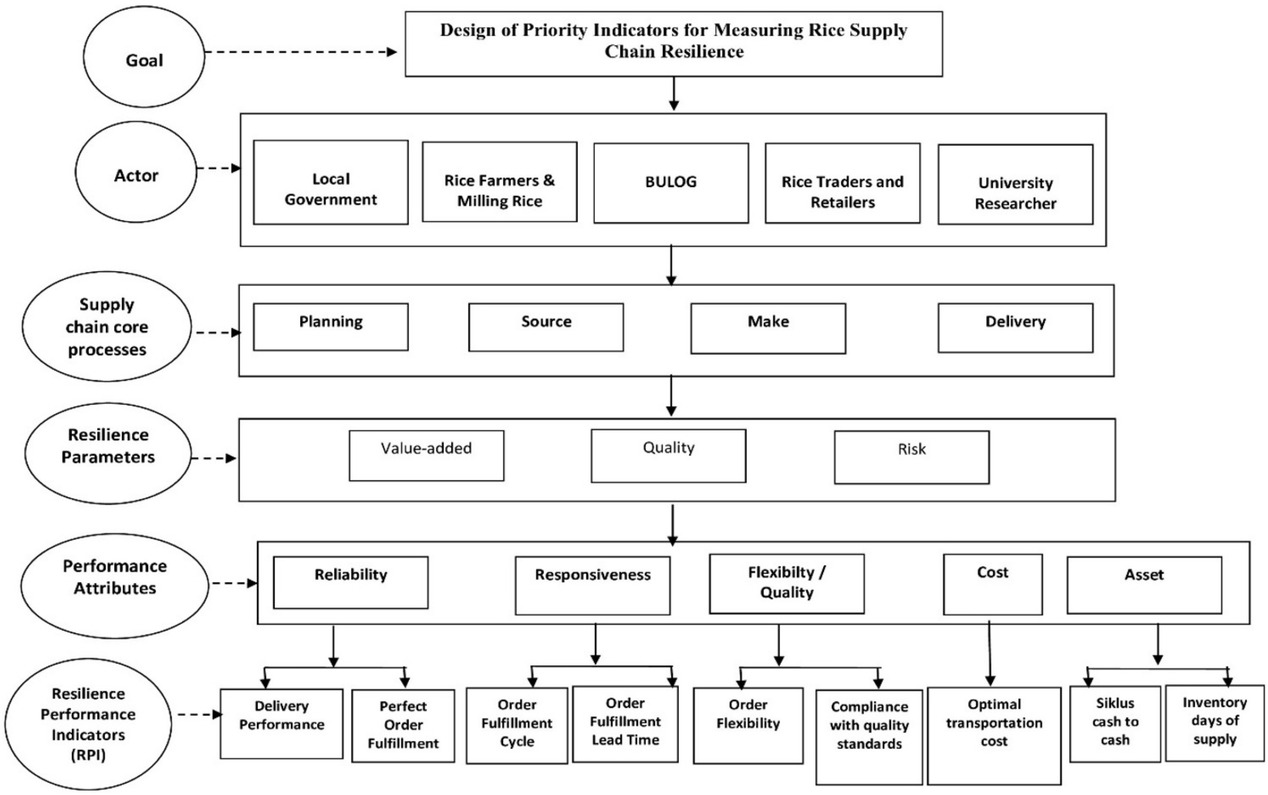

Figure 1: *Hierarchy of the selection of the rice supply chain resilience indicators in Gorontalo province.*

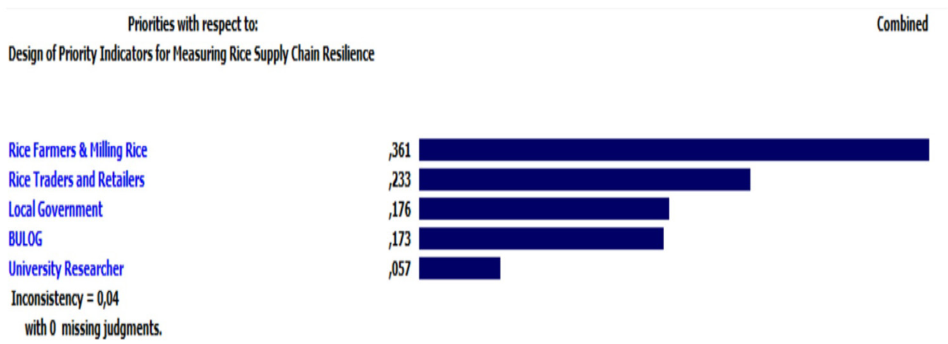

Figure 2: *Role level of the actor elements in relation to the focus elements.*

Based on Figure 2, the focus elements and the role level of the actors show that rice farmers and mills have the most important role in designing the rice supply chain resilience indicators in Gorontalo Province, with an importance weight of 0.361. The primary role of rice farmers in the rice supply chain is significant, as rice farmers and mills are the main producers of rice commodities. Farmers produce paddies, which serve as the starting point for the supply chain resilience. Farmers' involvement in this process extends beyond production, encompassing post-harvest activities like drying and selling to mills. Rice milling plays an important role in transforming paddy into consumable rice. Rice farmers and mills, as primary producers, play the largest role. Rice farmers and mills greatly contribute to the stability of the rice supply both in terms of the production volume and quality, which form the foundation for the sustainability of the entire rice supply chain system. This positions rice farmers and mills as the actors with the most impact on the supply chain resilience. They are the frontline that determines quality and quantity of rice production at the initial level, and disruptions at this stage can directly affect the rice availability in the market. This aligns with (Ahn, 2023), Low-income and food-deficit countries (LIFDCs) prioritized cereal imports, while other agricultural imports declined. Their supply chains were initially less resilient but recovered faster.

While each actor in the rice supply chain in Gorontalo Province plays a unique role, they all work together to maintain the supply chain resilience. Rice farmers and mills, as primary producers, play the largest role, followed by rice traders and retailers as the link between production and consumption. Local governments and BULOG play roles in policy regulation and price stability. BULOG acts as a provider of rice reserve stocks used for market intervention during shortages or significant price increases. BULOG's role in price and supply stabilization is crucial, especially in emergency situations such as natural disasters or major disruptions in rice production, as seen with the recent rise in rice prices. University reasearches support long-term development through research. A strong rice supply chain resilience requires an excellent collaboration among all actors for the ideal design of the rice supply chain resilience indicators based on the SCOR model in Gorontalo Province.

Role level of the core supply chain process elements in relation to the actor elements

The role level of the core supply chain process elements in relation to the actor elements in the design of the rice supply chain resilience indicators based on the SCOR approach in Gorontalo Province is presented in Table 1.

Table 1 shows that the design of the rice supply chain resilience indicators in Gorontalo Province using the SCOR approach interconnects four core supply chain processes with actors. For all actors, planning and make are the most dominant business processes in the design of the rice supply chain resilience indicators, with average weights of 0.337 and 0.305, respectively. This indicates that the local government plays a significant role in the policy planning stage and management of resources related to food security in Gorontalo. For farmers, the planning process is crucial for determining the planting times, cropping patterns, and the role of milling in managing the production results and optimal post-harvest practices. BULOG plays an important role in planning how to maintain national rice reserves and intervene in pricing during market fluctuations. The rice traders and retailers heavily rely on careful planning in relation to rice inventory and marketing strategies to meet consumer demand. They also have an interest in production, meaning they must maintain the quality of the rice they sell to meet the market standards. The researchers play an important role in conducting research and development related to planning that can support the rice supply chain resilience at both local and national levels.

Table 1: *Role level of the core supply chain process elements in relation to the actor elements.*

Core supply chain processes	Actor					Average
	Local government	Rice farmers and milling rice	BULOG	Rice traders and retailers	Univ. researchers	
Planning	0.337	0.337	0.337	0.337	0.337	0.337
Source	0.175	0.175	0.177	0.177	0.177	0.176
Make	0.305	0.305	0.304	0.304	0.305	0.305
Deliver	0.183	0.183	0.182	0.182	0.181	0.182

Source: *Processed data, 2024.*

For farmers, production is a highly important business process because the results of this activity are central to rice supply resilience, as the quality and quantity of agricultural output significantly affect the overall supply chain. Good production closely correlates with the availability of agricultural inputs, weather conditions, and cultivation and post-harvest techniques. The local government is responsible for formulating long-term strategies to ensure rice supply stability and maintain a balance between production and market needs. The production process also highlights the importance of local government involvement in ensuring agricultural productivity through technological assistance, superior seeds, and farmer training. BULOG's role in production is related to supervising the quality and quantity of rice stored and distributed. For rice traders and retailers, the production process may not directly link to agricultural activities but instead focuses on maintaining the distribution chain and guaranteeing product availability in the market. Research universities contribute to the development of technologies and methods that can enhance production outcomes in terms of both quantity and quality.

According to the research findings, planning is the primary indicator in the core process of the rice supply chain resilience. This suggests that the planning process functions as the central controller of the rice supply chain, balancing demand and supply to identify the most effective strategies for meeting procurement, production, and delivery requirements. In addition, according to Pujawan and Mahendrawathi (2017), planning encompasses processes such as forecasting distribution needs, inventory management and control, production planning, material planning, capacity planning, and aligning supply chain plans with financial strategies. This aligns with the results of (Anwar, 2018), who proposed improvements in the planning process as a priority for enhancing the university performance (Liputra *et al*., 2018) identified the performance indicators and attributes with the highest priority, which was the "compliance with product specifications" indicator under the "Reliability" attribute in the "Make" process of a company that produces product packaging.

Role level of the resilience parameter elements in relation to the core supply chain process elements

The role level of the resilience parameter elements in relation to the business process elements in the design of the rice supply chain resilience indicators based on the SCOR model in Gorontalo Province is presented in Table 2.

Table 2: *Role level of the resilience parameter elements in relation to the core supply chain process elements.*

Resilience parameters	Core supply chain process				Aver-age
	Planning	Source	Make	Deliver	
Value-added	0.240	0.229	0.213	0.247	0.232
Quality	0.433	0.486	0.478	0.443	0.460
Risk	0.327	0.285	0.309	0.311	0.308

Source: *Processed data, 2024.*

Based on Table 2, the most dominant resilience parameter is quality, with a weight of 0.460. This indicates that the quality of rice is a very important aspect in maintaining the stability and the sustainability of the rice supply chain in Gorontalo. Rice quality is determined by various factors including cleanliness, moisture content, texture, aroma, breakage, and nutritional value. In Gorontalo, the rice varieties most commonly cultivated by farmers are Ciherang and Mekongga. This community particularly favors high-quality rice, especially from the districts of Paguyaman, Wonosari, and Kabila. Consumers and traders prioritize quality because high-quality rice is more easily accepted in the market and has better storage durability. Based on interviews with the sample farmers, there is a prevailing mindset among the people of Gorontalo that, despite being poor, they should still consume high-quality rice.

In terms of the supply chain resilience, good quality will reduce the risk of losses due to price declines or consumer dissatisfaction. By maintaining quality, rice distribution becomes more reliable, reducing the risk of supply chain disruptions caused by rice failing to meet market standards. Risk management is a critical consideration for all stakeholders in the supply chain. The ability of actors to confront and mitigate risks plays a significant role in determining the resilience of the rice supply chain. This aligns with the findings of (Brusset and Teller, 2017), who stated that resources, routines, and capabilities produce varying outcomes in terms of resilience, depending on the risk factors within the supply chain.

Role level of performance attributes on the resilience parameter elements

The overall results of the strategy in designing indicators for the rice supply chain resilience based on the SCOR approach in Gorontalo Province are shown in Figure 3.

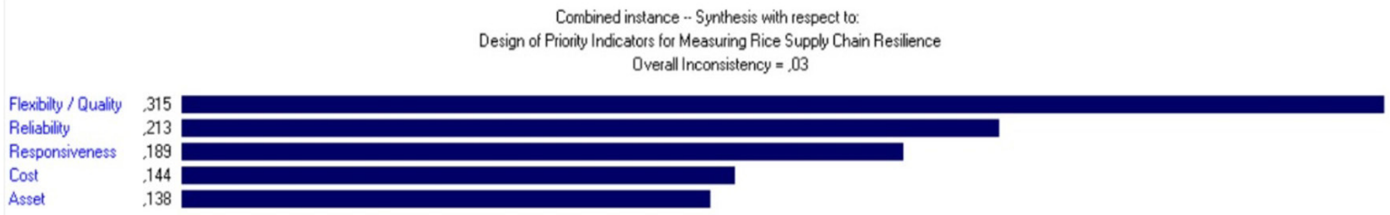

Figure 3: *Performance attributes in the design of indicators for the rice supply chain resilience.*

According to Figure 3, the most important performance attribute in the design of indicators for the rice supply chain resilience in Gorontalo Province is flexibility/quality, with a weight of 0.315. The people of Gorontalo believe that high-quality rice is defined by its white color, minimal broken grains, and soft texture. They value quality more than affordability. Even if rice prices are high, people of Gorontalo will still purchase it despite financial constraints. Furthermore, despite the availability of numerous new seed varieties from the Agriculture Office, including Imbrida, Hybrid, Pajajaran, and Cakra Buana, and the recently introduced Nutrizinc rice by the Agricultural Instrument Standardization Agency, farmers in Gorontalo still favor growing the Ciherang and Mekongga varieties. Farmers prefer these two varieties because buyers consistently seek them. This aligns with (Wen, 2020; Marinagi *et al*., 2015), in a fluctuating market, this flexibility is essential to ensure that the supply chain can meet consumer needs promptly and according to expectations. It will strengthen the supply chain resilience by ensuring that various operational challenges can be addressed without disrupting the flow of rice supply.

The reliability attribute ranks second in the design of the supply chain resilience indicators, with a weight of 0.213. The rice traders in Gorontalo's distribution performance has been quite optimal, even if the milling capacity in Gorontalo is generally still insufficient, averaging only 1.5 tons of rice. Rice deliveries are made daily, regardless of whether there is a large or small demand. The delivery time is also only 1–2 h depending on the distance to the market, particularly Moodu Thursday Market, Andalas Saturday Market, and Telaga Sunday Market. Additionally, if there are requests from consumers, traders usually deliver directly to homes.

Responsiveness is the third-ranked performance attribute with a weight of 0.189. The key resilience indicators for this attribute are order fulfillment cycle time and order lead time. In Gorontalo, farmers plant rice two–three times a year, particularly in Bone Bolango Regency, because of its extensive irrigation system. Farmers never stop planting, and there is no rest period between one planting season and the next. In 2023, the drought prevented many farmers from planting rice, causing the community's absorption of subsidized fertilizers to fall short of 100%. Furthermore, as the majority of farmers are tenant farmers, they do not have sole control over farming decisions, and they must share the harvest with the landowner. Although a drought disaster caused the planting season to be delayed from September 2023 to February 2024, the planting times in Gorontalo are not uniform across different areas.

With a weight of 0.144, the cost performance attribute ranks fourth. The resilience performance indicator focuses on achieving optimal transportation costs. The transportation costs throughout the Gorontalo region are quite low due to paved roads that are adequate for large trucks to pass through. Additionally, the distance from residential areas to markets is not very far, allowing traders to minimize their transportation costs. The exception is Tolangohula District, which is one of the main rice-producing areas in Gorontalo Regency, that is quite far from Gorontalo City. However, the paved and smooth roads mean that the travel time for rice traders is short, that is, only approximately 1–2 h to Gorontalo City. Meanwhile, Bone Bolango Regency, which directly borders Gorontalo City, has a travel time of only 15–30 min, resulting in low transportation costs for traders. Although premium fuel prices are relatively high, traders are still able to manage this. Furthermore, the National Food Agency's Pasar Mitra Tani program provides support to retail traders in the form of transportation costs subsidized by the central government. However, many traders do not participate in the program possibly because of the lack of outreach from the government.

The asset performance attribute, with a weight of 0.138, ranks fifth in the priority list of the rice supply chain resilience indicator design. The cash-

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to-cash cycle measures the time required to convert investments in raw materials (rice) into cash. Farmers in Gorontalo plant rice two–three times a year, which means that the production process from rice cultivation to grain takes around 4 months. This means farmers have to wait for 4 months to receive cash. As a result, farmers often rely on rice mills for living expenses because they frequently borrow money from the mills. Therefore, when the harvest time comes, farmers do not receive the full proceeds of their harvest because part of it is deducted to repay loans to the mills. This creates a cycle of debt. Consequently, farmers have a strong relationship with the mills, and even if the selling price at their partner mills is lower, they are unlikely to switch to another mill. Meanwhile, most rice traders in Gorontalo operate on a delayed cash payment system because consumers, particularly restaurant owners or sellers of yellow rice, often borrow rice from traders.

Table 3 presents the performance attribute results and the rice supply chain resilience performance indicators based on the SCOR approach in Gorontalo Province.

Table 3: *Performance indicators of the rice supply chain resilience.*

Performance attribute	Resilience performance indicators		Rank
	Indicator	Score	
Reliability	Delivery performance	0.501	4
	Perfect order fulfillment	0.499	5
Responsive-ness	Order fulfillment cycle	0.636	1
	Order fulfillment lead time	0.364	8
Flexibility/ quality	Order flexibility	0.424	7
	Compliance with quality standards	0.576	2
Cost	Optimal transportation costs	1.000	
Asset	Cash to cash cycle	0.563	3
	Inventory days of supply	0.437	6

Source: *Data processing, 2024.*

Based on Table 3, the order fulfilment cycle ranks first, and the order fulfilment lead time ranks last in the performance indicators for the rice supply chain resilience in Gorontalo. This is due to in the responsiveness attribute, the order fulfillment cycle is the most dominant resilience indicator with a weight of 0.636. The order fulfillment cycle includes the entire duration from the receipt of an order to the delivery of the rice to the customer. The shorter the cycle, the more responsive and efficient the rice supply chain is at meeting the market demands. This is crucial because the rice demand often fluctuates, especially during certain periods like harvest seasons or natural disasters. A supply chain that can shorten this cycle will be better prepared to handle market uncertainties and ensure the rice availability for consumers. A short fulfillment time is essential for the rice supply chain to meet consumer needs more quickly, especially during sudden demand surges. The combination of a quick cycle and the lead time will improve the supply chain resilience in responding to challenges and ensuring the rice supply remains stable. According to Indriani *et al*. (2024), farmers in Gorontalo cultivate two rice varieties, Ciherang and Mekongga, which have a growing period of 116 to 125 days. Moreover, the availability of production inputs, particularly subsidized fertilizers, is limited. Table 3 menyajikan hasil atribut kinerja dan indikator kinerja ketahanan rantai pasok beras berdasarkan pendekatan SCOR di Provinsi Gorontalo.

Although the planting-to-harvest period for farmers in Gorontalo is typically 4 months, the drought that hit Gorontalo in 2023 delayed the planting season. However, the cooperation between the Food Service and BULOG Gorontalo in conducting market operations, along with the influx of rice into Gorontalo, ensured that the rice needs of the community were met, even though rice prices remained high. Meanwhile, order fulfillment waiting time measures the time required to fulfill demand for rice from the time the order is placed until delivery is completed. The rice mill in Gorontalo operates every day during the rice harvest season. The Gorontalo Provincial Food Security Office and BULOG have rice reserves sufficient for the next 4 months. We have excluded costs from this ranking due to the absence of a comparison.

For another indicator, it can be explained as follows:
In the reliability attribute, the most dominant performance is delivery performance with a weight of 0.501. Delivery performance evaluates the supply chain's capability to provide rice on time and meet customer demand. The infrastructure in Gorontalo Province, especially in the main rice-producing areas like the Bone Bolango Regency and the Gorontalo Regency, is relatively good, with paved roads and adequate transportation for rice distribution throughout the region. Although its weight is slightly lower than the delivery performance, this indicator continues to have a substantial influence on the

resilience of the supply chain because if orders are not perfectly fulfilled, meaning the correct type and the quantity of rice, it can lead to economic losses and customer dissatisfaction, which consequently affects the rice supply system sustainability.

In the flexibility/quality attribute, the most dominant resilience indicator is the quality standard compliance with a weight of 0.576. Quality standard compliance refers to the supply chain's capacity to ensure that the rice produced and distributed adheres to the established quality standards. The rice mills in Gorontalo operate daily during the rice harvest season. The Food Security Agency of Gorontalo Province also has enough rice reserves for the next four months to meet public demand. The rice stock at BULOG consists of 932 tons of medium rice and 19,450 tons of rice stored in BULOG warehouses for 1 year. This enables us to meet consumer demand for rice, regardless of its size.

In the asset attribute, the most dominant resilience indicator is the cash to cash cycle with a weight of 0.563. In the cash-to-cash cycle, consumers in Gorontalo pay for rice in full to farmers or retailers in the market. However, at the level of collectors or wholesalers, they often experience delayed cash payments from consumers.

Transportation costs are one of the largest expense components in rice distribution because they involve transporting rice from farmers or producers to distribution centers and ultimately to consumers. Inefficient management can lead to increased costs, which in turn could affect the market rice prices. By optimizing the transportation costs, the supply chain can improve the overall cost efficiency without compromising the quality and reliability of rice delivery. This management is critical to keeping rice prices affordable for consumers. This aligns with Naziri *et al.* (2023), during the Covid-19 pandemic, social distancing measures led SMEs to shift towards more localized sales and break long supply chains by avoiding intermediaries and increasing the use of purchase contracts with partners.

In the assets attribute, the most dominant is cash to cash cycle with a weight of 0.563. Assets refer to everything used in the supply chain process, including physical infrastructures, such as warehouses, transportation tools, and technology, used to manage inventory. The cash-to-cash cycle measures the time it takes to convert cash invested in raw materials (rice) back into cash through sales. The shorter this cycle, the faster the supply chain can turn over the working capital, thereby improving liquidity and operational efficiency (Indriani *et al.*, 2019b; Sriwana *et al.*, 2021). In the rice supply chain, a short cash-to-cash cycle in the rice supply chain allows farmers or rice distributors to quickly access capital to expedite distribution or increase production when demand rises. The shorter the cycle, the more efficient the supply chain is at utilizing the working capital. With efficient inventory management, the rice supply chain can maintain a balance between having enough stock to avoid shortages and minimizing storage costs. This aligns with Siagian and Tarigan (2021); Suud *et al.* (2021), the combination of effective cash-to-cash management and efficiency in inventory days of supply will enhance the resilience of the supply chain.

Conclusions and Recommendations

The priority indicators of the rice supply chain in Gorontalo are as follows: Planning in the level of core process supply chain. the resilience parameters prioritized are quality. The performance attributes with the highest priority are flexibility. The performance indicators for the rice supply chain resilience include the order fulfillment cycle, quality standard compliance, cash-to-cash cycle, delivery performance, perfect order fulfillment, inventory days of supply, order flexibility, and order fulfillment lead time.

The research recommendations are to strengthen collaboration among actors in the rice supply chain to ensure a more cohesive and responsive supply chain. The combination of excellent planning stages, maintaining a product quality in line with quality standards, and flexibility, as well as managing the rice fulfillment and cash-to-cash cycles, will enhance the resilience of the rice supply chain in Gorontalo. Support farmers and small-scale actors with training and access to information or digital tools to help them align with resilience indicators.

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Novelty Statement

This study introduces novelty designing indicators for the food supply chain resilience, specifically for rice commodities, using the SCOR model attributes. There has been no previous research that used the SCOR model to assess the resilience of the rice supply chain. Therefore, the aim of the research is to design indicators for the rice supply chain resilience in Gorontalo Province, Indonesia.

Author's Contribution

Ria Indriani: Conceptualized the study, designed the methodology, and supervised the research process, writing original draft preparation, writing review and editing.
Supriyo Imran: Conceptualization, methodology, formal analysis, writing original draft preparation, writing review and editing.
Yuliana Bakari: Responsible for manuscript writing, editing, and final proofreading.
Siti Rahmatia Machieu: Conducted data collection, statistical analysis, and interpretation of results.
All authors reviewed and approved the final version of the manuscript and significantly to this research.

Conflict of interest
The authors have declared no conflict of interest.

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