Development of the Sea Fishery Supply Chain Performance Measurement System: A Case Study

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***Abstract*— Good performance measurement system is required to assess the success of supply chain. However, choosing the most appropriate indicator is not easy as it depends on the system's characteristics. Sea fishery industry characterized as perishable products, seasonal in production, and highly dependence on nature (uncontrollable). Motivated by the uniqueness of the sea fishery industry, this work proposed a performance measurement system for the sea fishery supply chain. The performance of the proposed model is evaluated using Indonesian sea fishery supply chain case, mostly consists of small and medium enterprises (SME). This instrument has six dimensions; efficiency, flexibility, responsiveness, product quality, process quality, facilities, and government involvement. Beside having specific indicators of sea fishery industry, the proposed instrument also considers the involvement of government. Further, this instrument can be used not only for monitoring but also suggesting directions for improvement.**

***Keywords*—** *performance measurement system, sea fishery, supply chain management*

1. Introduction

Increasing global market competition requires companies to be able to deliver appropriate products and services to the market faster, at the lower possible cost. Company should be able to formulate the best strategy to face the competition. In order to formulate the best strategy, the company should design good supply chain [8]. Supply chain is defined as an integrated process and flow of supply chain's members, starting from raw materials until the final product and covered the customer's need [3]-[8]. Good supply chain can be determined by measuring the performance using the appropriate performance measurement tools [2].

Some scholars propose performance measurement systems (PMS) on supply chain. Different approaches are used in developing the model, such as designing PMS by used hybrid DEMATEL and AHP [17], balance scorecard (BSC) [4] -[6]-[9]-[13]-[22]. There are also researches that held to determine the indicators of PMS on supply chain [7]-[10], and built the own model on supply chain of manufacturing industry [21]. There is also SCOR (Supply Chain Operation Reference) built by Supply Chain Council on 1996 [20].

Previous measurement systems are developed based on general characteristic of supply chain. However, it is important to use specific performance measurement tools that are suitable to the supply chain characteristics [3]-[12]. In this paper, we propose a performance measurement system for sea fishery supply chain. Sea fishery supply chain has specific characteristics that are different from other supply chains. Those characteristics are perishable, highly dependence on nature, seasonal, required special transportation and storage condition, and there are product safety issues. These characteristics would affect the performance of the supply chain. Thus, specific performance measurement system is required.

The characteristics of sea fishery supply chain, in general is similar with agri-food supply chain. However, there are some differences between agri-food supply chain and sea fishery supply chain. Sea fishery is more dependence on nature than agri-food, as it cannot be cultivated. In this work, the PMS for agri-food supply chain developed by [2] and SCOR –standard PMS for supply chain– are used as benchmark. The proposed PMS is designed to be simple, meet the characteristics of sea fishery, and covered entire process on sea fishery supply chain.

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2. Related Works

The purpose of PMS is to evaluate and to determine the best strategy to improve the supply chain. It is important to select appropriate PMS according to the characteristic of the supply chain [3]-[12]. Good PMS should meet the following criteria; inclusiveness, universality, measureability, and consistency [3].

Some PMS models have been developed. Various methods are proposed, starting from the use of cost as indicators, involving both financial and non-financial aspects, and the more complicated model that try to include the entire stakeholders on supply chain. Cost minimization uses cost as a single indicator to measure performance of the supply chain. This model is simple to use but disregard the stakeholders involvement and uncertainty factors in supply chain [3].

[10] considers the complexity of supply chain in two industries; automotive industry and pharmaceutical industry. This work provides analisys on company's strategic viewed by the criterias of well-designed of PMS (currently used PMS). The criteria of well-designed of PMS are a comprehensive approach, process-based, aligned with strategy, a dynamic system, balanced approach, a managerial tool, cover strategic, tactical and operational level, provide a forward looking (leading) perspective, tool for improvement, provide drill-down functionality, handling conflicting objectives, simple, comparability, relevant metrics. It is done by analysing and discussing how the criteria are applied on different companies. Thus, the drawback of company's strategic can be acknowledged, hence it can be used for preliminary step to improve the supply chain although it is not detail and spesific.

[7] propose a framework using a systematic approach to improve the iterative key performance indicators (KPIs) accomplishment in a supply chain context. It uses a process-oriented SCOR model to identify the basic performance measures and the KPIs. The proposed framework quantitatively analyzes the interdependent relationships among a set of KPIs. It enables to identify the crucial KPI accomplishment costs and propose performance improvement strategies for decision-makers in a supply chain.

[21] tries to determine the PMS used by selected Philippine manufacturing companies to monitor the effectiveness of their supply chain operations. A literature review is conducted to determine the supply chain performance measures. Survey method to the industry is used to discuss the relevance and applicability of the PMS. This study also try to find the effect of supply chain management strategies on performance.

Balance Scorecard (BSC) based measurement systems measure the performance of supply chain by involving four perspectives; financial perspective, customer perspective, process business perspective, and learning and growth perspective [14]. This framework involves both financial and non-financial aspects [15]. As many as 59% of scholars use BSC on the researches [18], such as the work done by [4]-[6]-[9]-[13]-[22]. However, still BSC have some weaknesses. The main weakness is the difficulty on using BSC (Ghalayini et al., 1996 in [11]) because the guidance for application is limited (Neely et al., 2000 in [11].

Performance prism framework assumes the chain on supply chain as a prism; with the side of prism describe the five criteria or indicators. Those five criteria are stakeholder satisfaction, strategies, processes, capabilities, and stakeholder contribution. This model is more comprehensive as it considers the stakeholders contribution that is disregarded by some models [15]. The drawback of the performance prism based measurement system is the difficulties in application and in this framework company is not allowed to make the appropriate strategy before stakeholders.

PMS in performance pyramid use pyramid shape with the level of criteria or indicators on its pyramid. The indicators on lowest level are quality, delivery, cycle time, and waste. The indicators on the second lowest are market and financial. While indicator on the top of the pyramid is corporate vision. In this framework the objective of the company is built from the top based on customer priority and measure it from the lowest. Performance pyramid integrates objective and operational indicator performance of the company. However, this framework does not have guidance to identify indicators and integrate that concept for continuous improvement [15].

System dynamics model is also a common model to measure the supply chain performance [1]. [2] use system dynamics to model indicators on supply chain performance measurement. The relationship between the indicators can be described properly by modeling it on system dynamics loop. This model is used if the relationship between indicators are known and well defined.

Due to the complexity of supply chain, various indicators have been proposed to measure its performance. [17] proposed a multiple criteria decision making (MCDM) tool to solve the problem of various parameters. MCDM enables the complexity to be defined and calculated properly. Analytical Hierarchy Process (AHP) and

DEMATEL are the popular MCDM approaches for prioritizing various attributes. [17] proposed a new methodology which is a combination of AHP and DEMATEL to rank various parameters affecting the performance of the supply chain. DEMATEL is used as it describes the relationship between the indicators, while AHP used to integrate indicators from entire aspects of supply chain.

There is also SCOR (Supply Chain Operation Reference) built by Supply Chain Council on 1996 [20]. SCOR is process-oriented of PMS, which are Plan, Source, Make, Deliver, and Return so it can cover the whole process on supply chain. The indicators determined by toolkit on each process. Although it is determined on each process, SCOR do not have the same indicators, because the indicators would be selected, screened and united. If the previous models are performance measurement for common case, but then adopted for supply chain performance, SCOR (Supply Chain Operation Reference) is developed as a specific performance measurement system for supply chain. SCOR consider more on the aspects in supply chain. SCOR measure the supply chain performance based on process-oriented on supply chain, which are Plan, Source, Make, Deliver, and Return [5]. This framework just focused on certain point, it cannot improve supply chain entirely [16]. It involves the process form upstream to downstream; therefore it cannot give the optimal result specifically. However, it includes entire process in supply chain, and tries not to pass any process in supply chain.

Ref. [2] developed PMS for agri-food supply chain, especially tomato industry. It measures the supply chain based on efficiency, flexibility, food quality, and responsiveness. Entire stakeholders on tomato industry are involved. The performance is total performance from each stakeholder.

The aforementioned models, however, cannot meet some specific characteristics of the sea fishery supply chain. The supply chain characteristics on sea fishery are as follows;

1. Seasonality in production
2. Natural conditions affect the quantity and quality of products
3. Shelf life constraints and perishability of products
4. Requires specific transportation and storage condition
5. Highly dependence on nature

In addition, nowadays, product safety issues on sea fishery are important issues. The use of formalin surely affected on the sea fish for consumption demand. In other side, good quality sea fish is the fresh fish which is has constraint on its shelf life. Table 1 shows the characteristics of the sea fishery supply chain and the existing performance measurement systems. However, none of the models consider entire characteristics of sea fishery supply chain characteristics.

Table 1. The characteristic of sea fishery supply chain compared with earlier PMS

The characteristic of seafish for consumption supply chain	BSC	SCOR	Performance prism	Performance pyramid	DEMATEL-AHP	System Dynamics	Agri-food
Seasonality in production	–	–	–	–	–	–	√
Shelf life constraints	–	–	–	–	–	–	√
Perishability of products	–	–	√	√	√	√	√
Natural conditions affect the quantity and the quality of products	–	√	–	√	–	–	√
Long time production time	√	√	–	√	√	√	√
Requires conditioned transportation and storage	√	–	√	–	–	–	√

Although agri-food supply chain [2] has similar characteristics with sea fishery supply chain, but it has differences. The dependence of agri-food supply chain on nature can be controlled because agri-food especially tomato can be cultivated, but in sea fishery industry, it is highly dependence on nature and uncontrolled. Further, sea fishery industries in Indonesia mostly is Small and Medium Enterprises (SMEs). In Indonesia, 99,91% companies are SMEs, thus SMEs have significant contribution to the nation. SME has some unique characteristics such as limited capital, limited technology, difficulty adoption to change, but has high contribution to the nation [19].

3. Framework Development

3.1 Object of the research

Object of this research is the supply chain of small and medium enterprises sea fishery industries in Yogyakarta, Indonesia (Figure 1). The upstream of this supply chain is fishermen as suppliers. The sea fish is then put to the Fish Auction Place (TPI). From TPI, the sea fish is transported to the wholesalers. The wholesalers will send the sea fish to retailer and company. From retailers, the fish sold to food stall. The sample on this research would be the SMEs, which are fishermen, TPI, Wholesalers, Retailers, and Foodstalls (see Figure 2).

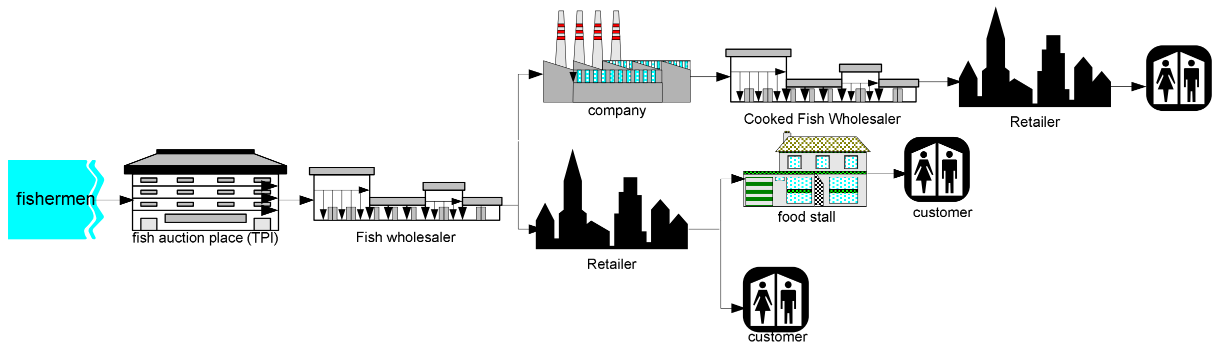

Figure 1. Seafish for Consumption Supply Chain

The total number of fishermen is 340 people. However, in this study, due to the difficulty in accessing all the fishermen, we use purposive sampling. The number of respondents is 44 fishermen, 4 TPI, 5 wholesellers, and 13 retailers.

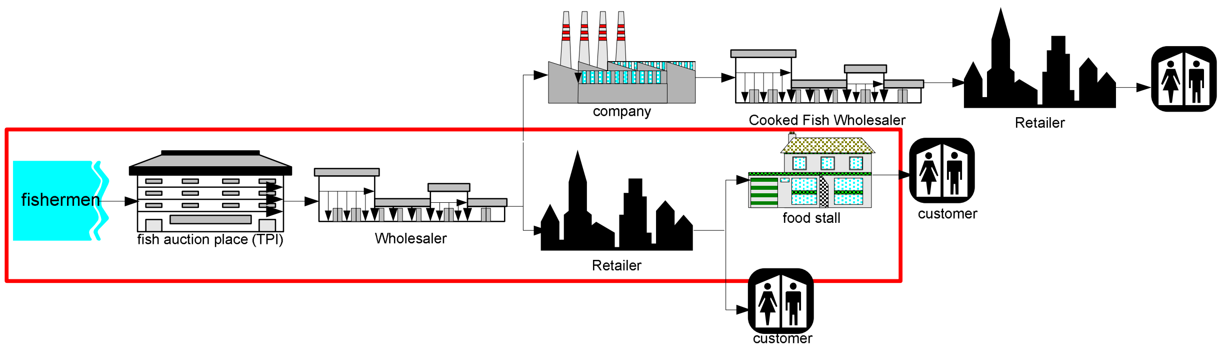

Figure 2. Sample of Sea fishery for Consumption Supply Chain

3.2 Data Collection

Some indicators are collected based on literature review. In this work, agri-food supply chain and SCOR will be used as a basis. The use of agri-food supply chain PMS as the basic as it has similar characteristics with sea fishery supply chain. But, sea fishery is more dependence on nature than agri-food. SCOR is used as a basis as it is the standard performance measurement for supply chain, to avoid losing of important indicators that is not covered by agri-food supply chain PMS. Screening on the indicators is done by means of focus group discussion with stakeholders.

Performance measurement on agri-food supply chain [2] is also used as the basic because of the similarity characteristics of both supply chain. This framework has 34 indicators grouped in four dimensions (Table 3).

Indicators from literatures are screened through a focus group discussion with expert stakeholders that are representative of fishermen, TPI, wholesaler, retailer, food stalls owner, and the Department of Marine and Fisheries (DKP). Table 4 shows the list of used indicators.

SCOR is a supply chain performance measurement method developed by the Supply Chain Council to measure supply chain performance based on the process. SCOR has 13 indicators (Table 2).

Stakeholders and the Department of Marine and Fisheries (DKP) are highly involved, hence the proposed measurement system can be used easily and accommodate the needs and characteristics of the supply chain.Some new indicators are also constructed based on the Focus Group Discussion. The respondents are fishermen, TPI workers, wholesaler, retailers, food stall owner, and the Marine and Fishery Department (DKP) as Government representative. Table 5 shows the indicators come from respondents.

In this PMS, five SCOR indicators are used; fill rate, production flexibility, value-added productivity, cash-to-cash cycle time (that changed to be punctuality to purchase), and asset turns. The cost-related indicators are combined into one indicator namely as total cost to make it simple to use.

Other indicators are adopted from agri-food supply chain developed by [2]. These indicators are product appearance, shelf life, salubrity, and energy. They represents the product quality. Product appearance and shelf life represents the perisability characteristic that requires conditioned handling and storage. Salubrity belongs to the quality of products that should be healthy and nutritious [2] and avoid the use of dangerous chemical substance like formalin. Energy use closely related to the nature condition that is uncontrolled and cannot be predicted accurately.

Table 2. SCOR Indicators

Performance Attribute	Customer-Facing			Internal-Facing	
	Reliability	Responsiveness	Flexibility	Cost	Assets
Delivery performance	√				
Fill rate	√				
Perfect order fulfillment	√				
Order fulfillment lead time		√			
Supply-chain response time			√		
Production flexibility			√		
Supply-chain management cost				√	
Cost of goods sold				√	
Value-added productivity				√	
Warranty cost or returns processing cost				√	
Cash-to-cash cycle time					√
Inventory days of supply					√
Asset turns					√

Table 3. Indicators of agri-food supply chain PMS

NO	Indicator	NO	Indicator
1	Production costs/distribution costs	18	Energy use
2	Transaction cost	19	Water use
3	Warranty cost	20	Pesticide use
4	Profit	21	Reuse/Recycle
5	Return on Investment ROI	22	Appearance
6	Delivery flexibility	23	Tate
7	Product lateness	24	Shelf life
8	Shipping errors	25	Salubrity
9	Traceability	26	Product safety
10	Fill rate	27	Product reliability
11	Backorders	28	Convenience
12	Lost sales	29	Working condition
13	Customer satisfaction	30	Storage and transport conditions
14	Customer response time	31	Inventory
15	Customer complaints	32	Volume flexibility
16	Promotion	33	Lead time
17	Customer service	34	Display in store

Some indicators also come from stakeholders. There indicators are computerized system, equipment, ice availability, dock, TPI office, cold storage, fishermen training, fishermen organization, accuracy of season forecasting, and price stability. Computerized system is needed to facilitate information sharing and traceability. Equipment is considered as it should be used wisely to optimize the profit. Ice availability indicator is used to support the perishable characteristics. It is used to make the shelf life product longer and it can be used to avoid the use of formalin. In addition to the use of ice, cold storage is used to overcome the weather uncertainty and the inaccuracy of the weather forecast indicators. Proper dock is also important as the activities highly depend on the quality of the dock. Next new indicator is the auction place, TPI. TPI is important place in this chain because it is place where all the stakeholders are met. On this chain, almost process are held on TPI, examples are movement of product, money, and information. Human resources are important keys in the success of supply chain. Hence, fishermen training and a good fishermen organization is important factor. Fishermen training and fishermen organization would make the fishermen stronger, rely on, smart, and good in quality. Another proposed indicator is price stability. Price stability is very important in this industry, and government involvement is a must. It is because the stakeholders on this chain are small and medium enterprises that are limited on capital, so fluctuate on price would affect bad things on the chain, example are unstable production until stopping the production.

Table 4. List of used indicators

NO	Indicators	Explanation	Measure	Aramyan et. al., (2007)	SCOR
L1	Total Cost	Combined costs of raw materials and labor in producing goods/combined costs of distribution, including transportation and handling cost	The sum of the total costs of inputs used to produce output/services (fixed and variable costs)	√	√
L2	Profit	The positive gain from an investment or business operation after subtracting all expenses	Total revenue less expenses	√	
L3	Return on Investment (ROI)	A measure of a firm's profitability and measures how effectively the firm uses its capital to generate profit	Ratio of net profit to total assets	√	
L4	Asset Turn	Total amount of assets owned by the company	The sum of total assets	√	√
L5	Delivery Flexibility	The ability to change planned delivery dates	The ratio of the difference between the latest time period during which the delivery can be made and the earliest time period during which the delivery can be made and the difference between the latest time period during which the delivery can be made and the current time period	√	√
L6	Product Lateness	The amount of time between the promised product delivery date and the actual product delivery date	Delivery date minus due date	√	√
L7	Fill rate	Percentage of units ordered that are shipped on a given order	Actual fill rate is compared with the target fill rate	√	√
L8	Customer satisfaction	The degree to which the customers are satisfied with the products or services	The percentage of satisfied customers to unsatisfied customers	√	
L9	Energy use	The amount of energy used during the production process	The ratio of cubic meters of gas used per square meter of glasshouse	√	
L10	Appearance	First sight of the tomato, combination of different attributes (color, size and form, firmness, lack of blemishes and damage)	Amount of damage, colour scale, size and form scale	√	
L11	Shelf life	The length of time a packaged food will last without deteriorating	The difference in time between harvesting or processing and packaging of the product and the point in time at which it becomes unacceptable for consumption	√	
L12	Salubrity	The quality of the products being healthy and nutritious	Nutritional value	√	
L13	Inventory	A firm's merchandise, raw materials, and finished and unfinished products which have not yet been sold	The sum of the costs of warehousing of products, capital and storage costs associated with stock management and insurance	√	√
L14	Productivity value-added	the company ability to give the added value on the product	Innovation that made in a period	√	√
L15	Volume flexibility	The ability to change the output levels of the products produced	Calculated by demand variance and maximum and minimum profitable output volume during any period of the time	√	√
L16	Lead time	Total amount of time required to produce a particularitem or service	Total amount of time required to complete one unit of product or service	√	√

Table 5. Indicators from Stakeholders

NO	Indicator	NO	Indicator
R1	Equipment	R8	needed employee
R2	punctuality to purchase	R9	accuracy of season forecasting
R3	ice avalaibility	R10	fishermen training
R4	dock	R11	price stability
R5	fishermen house	R12	Cold storage
R6	computerized system	R13	fishermen organization
R7	TPI office		

3.3 Setting Dimension

All indicators are then grouped based on dimensions. The dimensions adopted from agri-food supply chain PMS (Armayan et al. 2007) with additional dimension "government involvement". These dimensions are then verified by the stakeholders and DKP. Table 6 shows the proposed dimensions and indicators.

Table 6. The Proposed Dimension and the Indicators

Dimension	Code	Indicator	Dimension	Code	Indicator
Flexibility	L1	Total Cost	Process quality	L9	Energy use
	L4	Asset Turn		R8	Needed employee
	L2	Profit		R1	Equipment
	L13	Inventory		R3	Ice availibility
	L3	Return on Investment (ROI)		R4	Dock
Efficency	R2	Punctuality purchase		R6	Computerized system
	L5	Delivery Flexibility		R7	TPI office
	L14	Productivity value-added		R12	Cold storage
	L8	Customer satisfaction	Government involvement	R10	Fishermen training
	L15	Volume flexibility		R13	Fishermen organization
Responsiveness	L6	Product Lateness		R9	Accuracy season forecasting
	L7	fill rate		R11	Price stability
	L16	Lead time			
Product quality	L10	Appearance			
	L11	Shelf life			
	L12	Salubrity			

3.4 Weighting the Importance of the Indicators

The indicators that are grouped on dimensions are weighted. The weight is obtained by using questionnaire. The questionnaire contains of indicators, dimensions, the explanation of indicators, and the measurement of the indicators. The five likert scale is used for weighting the indicators. Likert scale is used as it is enable to show the respondent opinion, quick and easy to made, more reliable, and give many data and in interval data.

Having passed the validity and reliability test, the indicators are weighted to provide more information on the performance of the supply chain. Tabel 8 shows the weighted indicators. The value with * and highlight is the unimportant indicators, while the number with highlight is the important indicators.

Table 8. Weighted Indicators

Dimension	Code	Indicator	Weight					Weight (All)	Dimension Weight
			Fishermen	TPI	Wholesaler	Retailer	Food Stall		
flexibility	L1	Total Cost	4.6	4.3	4.4	4	4.4	4.3	3.9
	L4	Asset Turn	3.8	3.3	3.8	3.9	4.2	3.8	
	L2	Profit	4.5	2*	4.2	2.8	3.8	3.8	
	L13	Inventory	3.9	3.3	4.4	3.9	3.4	3.8	
	L3	Return on Investment (ROI)	3.9	1,7*	4.6	4	2.8	3.8	
efficiency	R2	Punctuality purchase	3.6	1,7*	4	2.9	2,6*	3.5	3.6
	L5	Delivery Flexibility	2.8	1,3*	3.6	2.8	2,6*	3.1	
	L8	Customer satisfaction	3.7	4.7	3.4	4.4	4.6	4.2	
	L14	Productivity value-added	4.2	2,6*	3.4	3.1	4.0	3.7	
	L15	Volume flexibility	4.2	3.3	3.2	3.4	3	3.4	
responsiveness	L6	Product Lateness	2.9	1,3*	4	2,7*	2.8	3.2	3.8
	L7	fill rate	2,1*	3.7	4.6	4.4	4.4	4.3	
	L16	Lead time	1,9*	3.3	4	4.2	4.4	4.0	
Product quality	L10	Appearance	4.4	2,7*	3.6	3.2	3	3.6	3.7
	L11	Shelf life	4.3	2*	4.2	2,7*	2,6*	4.0	
	L12	Salubrity	4.4	1*	3.4	3.7	3.6	3.6	
process quality	L9	Energy use	3.8	4.0	4.4	4.2	4.4	4.3	4.1
	R8	Needed employee	4.1	4.3	4.2	4.6	4.6	3.8	
	R6	Computerized system	3.1	4.7	3.6	2,6*	2,6*	4.2	
Facility	R1	Equipment	3.9	4.0	4	3.6	3.4	4.4	3.9
	R3	Ice availibility	4.2	4.0	4.2	3.8	2,4*	3.8	
	R4	Dock	4.0	2,7*	3	3.3	2,4*	3.8	
	R7	TPI office	3.3	4.3	2,6*	3.3	2,2*	4.1	
	R12	Cold storage	4.4	4.3	4.2	4.2	3.2	3.4	
Government involvement	R10	Fishermen training	4.1	4.0	4.2	4.3	4.4	3.6	4.0
	R13	Fishermen organization	4.1	2,7*	4.4	4.3	4	4.1	
	R9	Accuracy season forecasting	4.6	4.7	4.2	4.4	3.6	4.2	
	R11	Price stability	3.8	4.3	4.4	4.3	4.6	4.2	

3.5 Framework Design

The framework is designed to be easy to use. It is done as a basic performance measurement on sea fishery supply chain. The framework contains dimension, and the indicators in each dimensions. Explanation of the framework would show on table below the framework (see Table 9). The table contains explanation of indicators, the measurement of each indicators, and its metrics (criteria of bad, enough and good). The metrics made from deep discussion with stakeholders and DKP. The framework made as detail as possible to make stakeholders more understand and can use it as easy as possible. So, entire stakeholders can use it for individuality or for entire integrated supply chain.

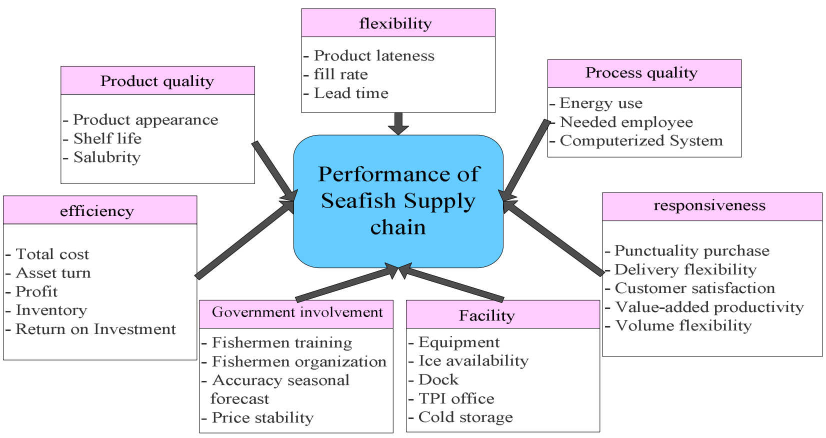

Figure 3. Framework of Performance Measurement Sea Fishery Supply Chain

4. Performance of The Proposed Framework

4.1 Case Study

The proposed PMS will be used to measure the performance of sea fishery supply chain in Yogyakarta, Indonesia. The measurement done by made the instrument from the framework. The instrument filled by the entire stakeholders on this chain, with the purposive sampling techniques. The results for the case study can be seen on Table 10.

Table 9. Explanation of the framework

Dimension	Indicators	Explanation	Measure	Stakeholders									
				Fishermen		TPI		Wholesaler		Retailer		Food stall	
				User	Weight	User	Weight	User	Weight	User	Weight	User	Weight
Efficiency	Total Cost	Combined costs of raw materials and labor in producing goods/combined costs of distribution, including transportation and handling cost	The sum of the total costs of inputs used to produce output/services (fixed and variable costs)	√	4.6	√	4.3	√	4.4	√	4	√	4.4
	Asset Turn	Total amount of assets owned by the company	The sum of total assets	√	3.8	√	3.3	√	3.8	√	3.9	√	4.2
	Profit	The positive gain from an investment or business operation after subtracting all expenses	Total revenue less expenses	√	4.5		2.0	√	4.2	√	2.8	√	3.8
	Inventory	A firm's merchandise, raw materials, and finished and unfinished products which have not yet been sold	The sum of the costs of warehousing of products, capital and storage costs associated with stock management and insurance	√	3.9	√	3.3	√	4.4	√	3.9	√	3.4
	Return on Investment (ROI)	A measure of a firm's profitability and measures how effectively the firm uses its capital to generate profit	Ratio of net profit to total assets	√	3.9		1.70	√	4.6	√	4	√	2.8
Flexibility	Punctuality to purchase	Punctuality to purchase from transaction date (transaction among fishermen, TPI, wholesaler, retailer, food stall, or buyer)	The difference in time between agreed purchase date with actual purchase date	√	3.6		1.70	√	4	√	2.9		2.6
	Delivery Flexibility	The ability to change planned delivery dates	The ratio of the difference between the latest time period during which the delivery can be made and the earliest time period during which the delivery can be made and the difference between the latest time period during which the delivery can be made and the current time period	√	2.8		1.3	√	3.6	√	2.8		2.6
	Customer satisfaction	The degree to which the customers are satisfied with the products or services	The percentage of satisfied customers to unsatisfied customers	√	3.7	√	4.7	√	3.4	√	4.4	√	4.6
	Productivity value-added	the company ability to give the added value on the product	Innovation that made in a period	√	4.2		2.6	√	3.4	√	3.1	√	4
	Volume flexibility	The ability to change the output levels of the products produced	Calculated by demand variance and maximum and minimum profitable output volume during any period of the time	√	4.2	√	3.3	√	3.2	√	3.4	√	3
responsiveness	Product Lateness	The amount of time between the promised product delivery date and the actual product delivery date	Delivery date minus due date	√	2.9		1.3	√	4		2.7	√	2.8
	Fill rate	Percentage of units ordered that are shipped on a given order	Actual fill rate is compared with the target fill rate		2.1	√	3.7	√	4.6	√	4.4	√	4.4
	Lead time	Total amount of time required to produce a particularitem or service	Total amount of time required to complete one unit of product or service		1.9	√	3.3	√	4	√	4.2	√	4.4
Product quality	Appearance	First sight of the tomato, combination of different attributes (color, size and form, firmness, lack of blemishes and damage)	Amount of damage, colour scale, size and form scale	√	4.4		2.7	√	3.6	√	3.2	√	3
	Shelf life	The length of time a packaged food will last without deteriorating	The difference in time between harvesting or processing and packaging of the product and the point in time at which it becomes unacceptable for consumption	√	4.3		2.0	√	4.2		2.7		2.6
	Salubrity	The quality of the products being healthy and nutritious	Nutritional value	√	4.4		1.0	√	3.4	√	3.7	√	3.6
Process quality	Energy use	The amount of energy used during the production process	The ratio of cubic meters of gas used per square meter of glasshouse	√	3.8	√	4.0	√	4.4	√	4.2	√	4.4
	Needed employee	The total amount of needed employee in entire process to produce the product from fishermen until received by the customer	The total amount of employee per unit production	√	4.1	√	4.3	√	4.2	√	4.6	√	4.6
	Computerized system	The availability of computer and the system to save the data, transaction, trace the transaction and data, etc.	The ratio of computer in good condition compared with the needed computer	√	3.1	√	4.7	√	3.6		2.6		2.6

Table 9. Explanation of the framework (continued)

Dimension	Indicators	Explanation	Measure	Stakeholders									
				Fishermen		TPI		Wholesaler		Retailer		Food stall	
				User	Weight	User	Weight	User	Weight	User	Weight	User	Weight
Facility	Equipment	The total amount of whole equipment to produce the product	The ratio of total amount of availibility equipment compared with the needed equipment	√	3.9	√	4.0	√	4	√	3.6	√	3.4
	Ice availibility	The stability of ice avalibility in entire chain	The ratio of total amount of availibility ice compared with the needed ice	√	4.2	√	4.0	√	4.2	√	3.8		2.4
	Dock	The availability of standarize dock	Goverment checks and monitoring processes according to certification schemes	√	4.0		2.7	√	3	√	3.3		2.4
	TPI	The availability of standarize TPI	Goverment checks and monitoring processes according to certification schemes	√	3.3	√	4.3		2.6	√	3.3		2.2
	Cold storage	The availability of cold storage to keep the fresh fish to stay fresh (stock for famine season)	The ratio between capacity of cold storage compared with the the amount of seafish	√	4.4	√	4.3	√	4.2	√	4.2	√	3.2
Government involvement	Fishermen training	Fishermen training related to work condition, nature factor in the sea (wave & wind), and another skills	The amount of fishermen training every year	√	4.1	√	4.0	√	4.2	√	4.3	√	4.4
	Fishermen organization	The productivity of fishermen organization to arrange the activitis, welfare, etc	The amount of fishermen organization meeting every month	√	4.1		2.7	√	4.4	√	4.3	√	4
	Accuracy season forecast	the accuracy of season forecasting to predict the right time to catch the seafish	The amount of right season forecast every year	√	4.6	√	4.7	√	4.2	√	4.4	√	3.6
	Price stability	The guarantee of standarize price in surplus or famine	The amount of price fluctuation every year	√	3.8	√	4.3	√	4.4	√	4.3	√	4.6

Table 10. Performance of Sea Fishery Supply Chain in Yogyakarta using the Proposed PMS

No	Stakeholder	Performance Score
1	Fishermen	1.893
2	TPI	2
3	Wholesaler	2
4	Retailer	1.857
5	Food Stall	1.857

4.2 Comparison with SCOR

The proposed PMS will be compared with SCOR as to measure the performance of sea fishery supply chain in Yogyakarta, Indonesia. The mean of the results of the proposed PMS and SCOR are similar, i.e. fishermen is 1.893 (proposed PMS) and 1.917 (SCOR), the performance of TPI is 2 (proposed PMS) and 1.833 (SCOR), wholesaler's performance is 2 on both PMS, retailer is 1.857 (proposed PMS) and 1.917 (SCOR), food stall is 1.857 (proposed PMS) and 2 (SCOR). The result is tested by statistical method to prove the differences on sea fishery PMS and SCOR. For this case paired sample t-test is used. Using $\alpha = 0.05$, it can be concluded that there is no significant different for both instruments.

Although the result is not significantly different, but the PMS of sea fishery supply chain is more detail than SCOR. The details are on the indicators that are described specifically and appropriately for sea fishery supply chain. The first detail is about the indicators. Indicators in the proposed PMS are specific for sea fishery industry but SCOR measures supply chain generally. Further, the proposed PMS can be used for improvement specifically on the performance that has bad values in the respective indicators.

The second detail is about the weighted indicators. The importance of weighted indicators is that it can be used for continuous improvement. This instrument enables company to focus on the improvement in which the indicators indicates bad performance. It can be done by plotting the indicators on Iimportance-Performance Analysis (IPA) chart. IPA chart formerly used to plot customer satisfaction (perception) and the importance (expectation). This chart is adopted on this research. The use of IPA facilitates the stakeholders to see the indicators are already good or indicators that need improvement easily.

IPA chart is developed by plotting the mean of weighted indicators (Y) and the means of performance (X) on Cartesian diagram, to see in which quadrant the position for each indicator. Table 11 shows the weighted indicators data dan the IPA chart for the performance of supply chain observed can be seen on Figure 4.

Table 11. Weighted Indicators (Y) and Supply Chain Performance (X)

Code	Indicator	Y	X
		Weight (mean)	Performance (mean)
L1	Total Cost	4.34	1.80
L4	Asset Turn	3.80	3.00
L2	Profit	3.82	2.00
L13	Inventory	3.79	1.00
L3	Return on Investment (ROI)	3.82	1.80
R2	Punctuality purchase	3.50	2.80
L5	Delivery Flexibility	3.08	2.00
L8	Customer satisfaction	4.15	2.20
L14	Productivity value-added	3.68	2.20
L15	Volume flexibility	3.43	1.40
L6	Product Lateness	3.23	2.40
L7	fill rate	4.27	1.20
L16	Lead time	3.98	2.60
L10	Appearance	3.55	1.80
L11	Shelf life	3.98	1.60
L12	Salubrity	3.55	1.00
L9	Energy use	4.27	2.80
R8	Needed employee	3.78	2.00
R6	Computerized system	4.16	1.60
R1	Equipment	4.36	1.60
R3	Ice availibility	3.79	1.80
R4	Dock	3.79	1.40
R7	TPI office	4.05	1.60
R12	Cold storage	3.42	1.40
R10	Fishermen training	3.64	2.00
R13	Fishermen organization	4.07	2.80
R9	Accuracy season forecasting	4.20	2.00
R11	Price stability	4.21	2.00
Mean		3.85	1.92

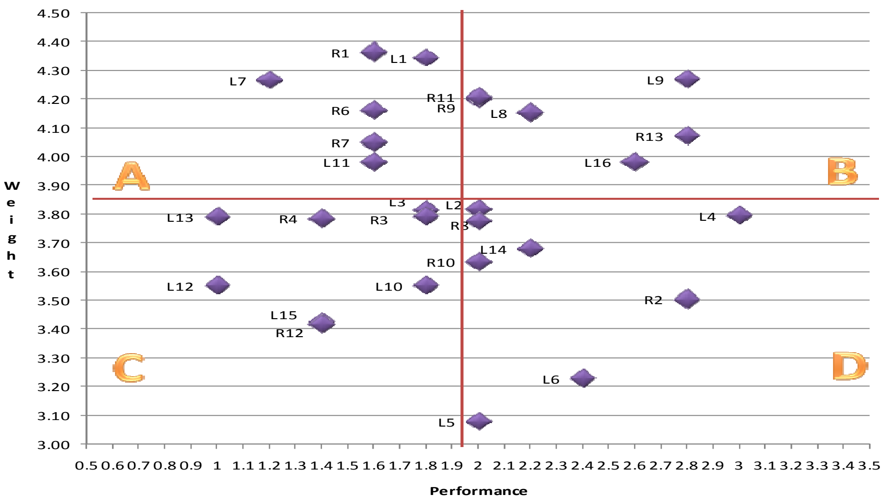

Figure 4. IPA Chart for the Case Study

The indicators on quadrant A are classified as having bad performance but important. The indicators in this quadrant are equipment, TPI, shelf life, computerized system, fill rate, and total cost. Those indicators are prioritized to be improved. The indicators on quadrant B are categorized as having good performance and also important. They are price stability, accuracy of seasonal forecast, customer satisfaction, lead time, fishermen organization, and energy use. The indicators on quadrant C are the indicators that are needed but not so important and the performance is good enough. The indicators on quadrant D are the indicators that are not important and the performance is very good. It means, there is possibility to have over treatment on these indicators, hence the sources on this indicators will be better if it is allocated to indicators in quadrant A.

The performance of the proposed PMS also evaluated by using user perspective. In this case, we blindly compare our proposed PMS and SCOR. DKP is used as respondents. Table 12 shows the user's perspective on the proposed PMS and SCOR as the benchmark PMS. We use criteria of the good PMS proposed by [15].

Table 12. The comparation of fulfill the instrument prerequirement

No	Prerequirement	DKP 1		DKP 2		DKP 3	
		SCOR	Seafish	SCOR	Seafish	SCOR	Seafish
1	Be simple and easy to use	√		√	√	√	√
2	Have a clear purpose.	√	√		√	√	√
3	Provide fast feedback.	√	√		√		√
4	Relate to performance improvement, not just monitoring.		√		√		√
5	Reinforce the firm's strategy.	√	√	√	√	√	√
6	Relate to both long-term and short-term objectives of the organization.	√	√	√		√	
7	Match the firm's organization culture.		√		√		√
8	Not conflict with one another.	√	√		√		√
9	Be integrated both horizontally and vertically in the corporate structure.	√	√	√		√	
10	Focus on what is important to customers.			√	√		√
11	Lead to identification and elimination of waste.	√	√		√	√	√
12	Establish specific numeric standards for most goals.	√	√		√		√
13	The financial and non-financial measures must be aligned and fit within a strategic framework.	√	√	√		√	
14	It must reflect relevant non-financial information based on key success factors of each business.		√	√			√
15	Inclusiveness	√	√		√	√	
16	Universal		√	√	√		√
Total		11	14	8	12	8	12

5. Conclusion

The proposed performance measurement system specific on sea fishery supply chain has been proposed. This instrument has six dimensions, which are efficiency, flexibility, responsiveness, product quality, process quality, facilities, and government involvement. The performance of the proposed PMS is as good as SCOR. However, this instrument have some indicators that are more specific on the sea fishery characteristics. Also the proposed PMS provides recommendation on indicators that needs to be improved.

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