Supply Chain Performance Analysis of Plant Seedling Distribution System Using Supply Chain Operations Reference Method

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ABSTRACT

In the industrial world, distribution activities are one of the important things in the flow of a business process. The role of advances in information technology also has a considerable good impact on the process of exchanging information in business processes. The XYZ agency is responsible for organizing the distribution of plant seeds to all communities and farmer groups as an effort to improve the economy in the agro-industrial sector. However, there are obstacles in the distribution process activities carried out by the XYZ agency such as the lack of harmonization of information exchange with regional posts. This causes the distribution process to be hampered and also not even distributed. Therefore, it is necessary to describe the process flow using the Supply Chain Management (SCM) method to manage seeds distribution management appropriately. SCM elaborates each supply chain process in detail by categorizing each process with the attributes of plan, source, make, deliver, and return. In addition, performance measurement using the Supply Chain Operations Reference (SCOR) model is carried out to determine and provide recommendations for improvements needed for each related performance metric. There are 31 Key Performance Indicators (KPI) that are in accordance with the distribution process and validated in XYZ agency. The result of performance measurement based on the Key Performance Indicator reached 83.12, which indicated the performance monitoring of the actual seeds distribution process by XYZ agency at the Good level.

1 Introduction

XYZ agency is a government department in the field of environmental and forestry that is engaged in the field of nature reserves, forest management and utilization, conservation of natural resources, social counseling, enforcement of environmental and forest protection laws. As an effort to green activities and welcome the economic growth of the agro-industrial sector, XYZ agency has a plant seeds distribution program to all components of the community and farmer groups to improve the local economy and spring preservation. However, in the implementation of distribution activities, there are still several obstacles that can occur from both internal and external scopes. Some obstacles often occur due to data mismatches during the seedling stock data collection process.In addition, the occurrence of miscommunication during the distribution process occurs due to lack of coordination and rarely well-organized various parties involved in the distribution process so that it does not run in a balanced way.

SCM is an integrative method used to manage product flow, material procurement, delivery processes, services and product development from upstream to downstream. SCM includes an overview of product distribution patterns that can reconfigure traditional distribution patterns into more optimized products. This new pattern has a core that concerns distribution activities, production schedules, and logistics so that the distribution process runs in a strategic manner (Bastas & Liyanage, 2019). Measuring the performance of the agency's internal distribution process needs to

be done by determining the extent of readiness in carrying out the process. Performance measurement uses the Supply Chain Operation Reference (SCOR) model which analyzes the comparison of supply chain activities and performance as a cross-industry supply chain management standard (Reddy. K et al., 2019).

The research to analysis the distribution process using the SCM method and the SCOR model is expected be the best solution to solve the existing problems. The implementation of SCM and SCOR models is also expected to improve the agency's performance in distributing plant seeds. The utilization of information technology is real by automating the data collection and management process of seedling distribution.

2 The Proposed Algorithm

The introduction section has explained the problems contained in the research to be carried out. In solving these problems, it is necessary to have theories that are related and can be used as a solution. This ensures that the research conducted gets a broad perspective of insight.

2.1 Distribution

Distribution is the activity of distributing or bringing products such as goods or services to the buyer's reach. Distribution is also a marketing channel used by product creators of an organization or company to be sent to industries or end consumers (Zulkarnaen et al., 2020). The purpose of distribution itself is the delivery of products that are able to be strategically organized in an uncertain amount, which is expected to minimize the costs and time required, be flexible, and be accessible to consumers (Pamungkas, 2019).

2.2 Supply Chain Management (SCM)

SCM is a combination of methods, tools, and management of supply chain relationships between companies that are interrelated, and work in accordance with what is supposed to happen (Oktavianus, 2019). SCM includes a set of business processes that include scheduling, coordinating, controlling product procurement, production processes, and delivery to customers. SCM is very complex and is usually applied in large companies to increase effectiveness, efficiency, and cost expenditure (Khan et al., 2021).

2.3 Supply Chain Operations Reference (SCOR)

SCOR is one of the reference models for a number of processes included in the supply chain operations section. SCOR is able to be mapping a part of several supply chain processes. SCOR is basically a model that refers to a supply chain procedure. The SCOR model applies to SCM by emphasizing the observation and assessment of the performance from all supply chain processes (Birkel & Müller, 2021). In the SCOR model there is a level in the process of implementing and measuring work in the supply chain. The SCOR model tiers provide a technically defined structure and framework for measuring supply chain performance. In addition, the SCOR model is also a benchmarking method to determine gap analysis and best practice steps in continuous improvement efforts. The following is a description of the supply chain performance measurement flow (Sundarakani et al., 2018).

3 Method

This research was conducted based on the identification of problems that have been discussed in the introduction of the research. Literature studies are used to find references to related scientific studies as a support for scientific research theory. Data collection was carried out using observation, interview, and questionnaire techniques in an effort to find answers for existing problem identification. Observation focuses on the distribution process of plant seeds carried out by XYZ Agency by integrating the SCM concept. Performance measurement is also carried out using the SCOR model to determine the performance monitoring of the distribution process carried out by the agency. The flow of the research process is presented in Figure 1.

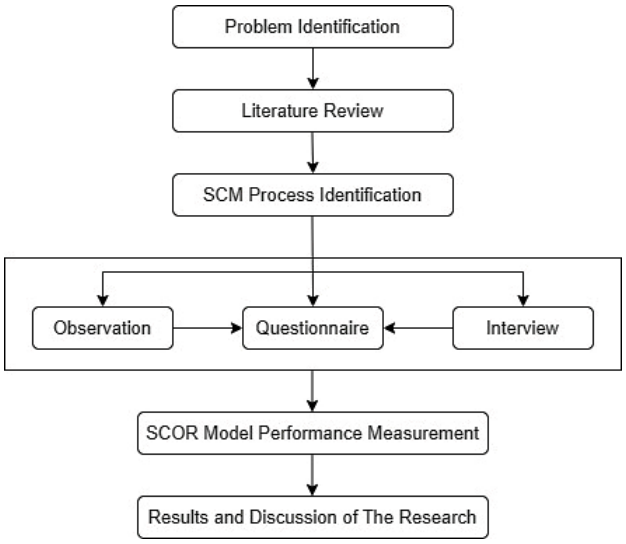

Figure 1. Research Process Flow

3.1 SCM Process Identification

The identification of the SCM process is based on observation and interview to describing each distribution process implemented by XYZ Agency. The distribution process is decomposed into parts of each process in the SCM guidelines. The decomposition of the distribution process is divided into the plan, source, make, deliver, and return processes. An explanation of the process decomposition according to the SCM guidelines is described in Table 1.

Table 1. Decomposition of SCM Processes (Koberg & Longoni, 2019)

Process	Definiton
Plan	Business strategy process to balance demand and supply in order to build the best strategy of each supply chain activity with synchronization to the applicable business rules.
Source	The process of collecting and procuring material goods or services by considering aspects of business qualifications in meeting planned needs.
Make	The process that transforms goods to the completion stage (Processing, producing, and packaging finish good) to meet the needs of the market target.
Deliver	The process of distributing finished goods and services to meet the needs of end consumers.
Return	The process of asset management regarding the return of goods after the entire distribution process occurs.

3.2 SCOR Model Performance Measurements

Performance measurement using the SCOR model consists of two types of elements, which are metrics and performance attributes. Metrics are tools for measuring the standardized performance of supply chain processes, whereas, those performance attributes are metrics that are calculated as part of the performance measurement process. Each performance attributes that are related to business strategies will have their own benchmarks in the SCOR model metrics. The following is an explanation of the work attributes contained in the standard metrics of the SCOR model presented in the Table 2.

Table 2. SCOR Performance Attributes (Sholeh et al., 2021)

Process	Definiton
Reliability	Ability to complete each job as scheduled.
Source	Response time of each realization and function of the entire supply chain process.

Agility	Flexibility in responding to changes caused by both internal and external factors in the supply chain process.
Cost	Consideration of costs during the supply chain process.
Asset Management	Asset utilization management efficiency with respect to the utility value of goods, product stock depreciation, and inventory management.

3.2.1 *Performance Metric Value Normalization Using Snorm De Boer*

Each performance standard has different units of value (parameters). Different parameters need to be regulated to equalize the parameter units. Parameter unit equalization is carried out from each performance metric used to calculate the final value of the company's supply chain performance. The result of the calculation of the normalized value achieved is called the Snorm De Boer equation (Waaly et al., 2018). The result of the calculation of the normalization value obtained is called the Snorm De Boer equation. The Snorm De Boer equation formula for higher better is presented in equation (1). The Snorm De Boer equation for lower better is presented in equation (2) and alternatively in equation (3).

If the measurement is higher better:

$$S_{norm} = \frac{(S_i - S_{min})}{S_{max} - S_{min}} \times 100\% \quad (1)$$

If the measurement is lower better:

$$S_{norm} = \frac{(S_{max} - S_i)}{S_{max} - S_{min}} \times 100\% \quad (2)$$

Or

$$S_{norm} = \frac{(Score - 0)}{100} \times 100\% \quad (3)$$

Description:

Si = Actual indicator value achieved

Smin = The lowest or worst performance achievement value of the performance indicator

Smax = The highest or best performance achievement value of the performance indicator

Score = The actual indicator value obtained directly from a series of performance processes

3.2.2 ***Measurement of Weight Values on Each Performance Attribute.***

Giving weight values to each performance attribute is based on the questionnaire obtained. The SCOR performance attribute weighting questionnaire uses the Saaty Scale as a reference. Saaty Scale assessment by making comparisons between paired attributes. As a guide to the consistency of the answers given by respondents, the Saaty scale considers the judgment value of the Consistency Index (CI) of ≤ 0.1. Calculation of weighting values on the Saaty Scale using the *Expert Choice* software version 11. Explanation of the scoring on the Saaty scale is presented in Table 3.

Table 3. Saaty Scale (Hadiana et al., 2022)

Importance Level	Definition	Description
1	Same Importance	Both attributes have the same impact
3	Slightly More Important	Experience and judgment explosively prefer one attribute over another

5	More Important	One attribute is highly preferable and almost dominant, compared to the other attributes
7	Very Important	One attribute proves to be more preferable and almost dominating, compared to its counterpart
9	Absolutely Most Important	One attribute is strongly preferred over its counterpart, at a high trust position
2,4,6,8	Middle Value	Value between two adjacent options

3.2.3 *Calculation of Actual Value of Supply Chain Performance.*

The final stage is to calculate the value of Supply Chain performance by calculating the value of each actual achievement with a weight using the SCOR performance for each attribute. To get the final value of actual performance starts by calculating the value of each performance metric multiplied by the weight borne called the level 3 process. If the final value is obtained from the process level 3 performance metrics, it is added up according to the process dimension so that the performance dimension value is obtained.

The level 2 process is carried out if the value of the performance dimension is multiplied by the weight borne. Calculation of the value at process level 2 obtained process performance values that will be calculated to determine process performance values. In the final process or level 1, the total value of the process performance value is summed up with the insured weight so that the actual result of the performance value according to the SCOR model is obtained (Suryaningrat et al., 2021). The SCOR model calculation formula is presented in equation (4).

$$P_i = \sum_{j=i}^{n} Sij\ Wj \quad (4)$$

Description:

Pi = Total supply chain performance number-*i*

n = Number of performance objects

Sij = Score of supply chain number-*i* in performance objective number-*i*

Wj = Weight of performance objective

3.2.4 *Performance Indicator Monitoring.*

After obtaining the actual performance score from the supply chain analysis and SCOR model calculation, the process category of the obtained performance score value can be determined. Low-high achievement categories are determined using an index monitoring system. The monitoring system is grouped based on five factors of performance achievement range starting with the lowest performance, marginal performance, medium-good performance, good achievement performance, and superior or excellent achievement performance. Table 4 presents the range of process performance achievements obtained by process performance monitoring categories.

Table 4. Performance Indicator Monitoring System (Rakhman et al., 2018)

Monitoring System	Performance Indicators
< 40	Poor
40 – 50	Marginal
50 –70	Average
70 – 90	Good
> 90	Excellent

4 Results and Discussion

The results and discussion of the research conducted refer to the series of research method process flows that have been described. The results of the research discussed focus on identifying the SCM process carried out by XYZ Agency, measuring the performance of seedling distribution, and developing information systems based on SCM and SCOR.

4.1 Identification of SCM Process

The first stage before the distribution process begins is planning the distribution process. The planning of the distribution process includes the targets and objectives of the seedling recipients, the seedling production process undertaken by XYZ agency, importing seedlings from outside the agency and how to choose a good supplier, as well as the management of the distribution process that occurs and the management of assets included in the distribution process.

The second stage in the distribution process is the procurement of seedlings by the agency. The purpose of agencies procuring additional seedlings is to fulfill the need for seedling stock during the distribution process. Agencies cannot rely solely on independent seedling production due to the large demand for seedling stock in large quantities. Seedlings are supplied by the agency's partners once every four months, while if there is a large demand for seedlings, the delivery process can be accelerated to once every three months.

The third stage is the seedling production process carried out by XYZ Agency. The seedling production process is carried out based on the number of types of seedlings that are often requested during the seedling distribution process. Seeding is done by selecting quality seeds according to the type of plant. The seeding process begins with sowing seeds in a seedling tub that has been given a planting medium. The seeding process lasts about 1-2 weeks until sprouts or shoots grow. In the next process, the sprouts or shoots that are 1-2 weeks old will be transferred to the seedling polybag which will be nurtured into ready-to-grow seedlings for approximately 3-4 months.

The fourth stage is the seedling delivery process, there are 2 seedling delivery processes in the XYZ agency. The first is the delivery of seedlings from suppliers to agencies and the second is from agencies to special requests. The seedling delivery process from the supplier to the agency lasts between 3-5 days depending on the type of vehicle and the number of seedlings distributed. After the seedlings are received by the agency, they will then be distributed to the extension posts in each region. The quantity that can be loaded by the supplier's vehicle ranges from 3000 to 5000 seedlings in one shipment process. The next delivery process is the delivery of seedlings by the agency to special requests. Delivery of seedlings to special requests is usually carried out if there is an agenda for fellow agencies or to be distributed to extension posts. Seedling deliveries made by agencies are loaded in a "Hilux" type vehicle that can carry up to 1000 seedlings in one delivery process.

The fifth stage is asset and stock management during the distribution process. Seedling stock management is carried out by maintaining and controlling pests on the seedlings. The purpose of treating and controlling pests on the seedlings is to prevent the seedlings from being attacked by diseases that cause wilting. If there is no management of the seedling stock stored at XYZ Agency, it can cause a stock imbalance in the seedling data. This causes the distribution process to be disrupted so that the distribution process is uneven. In addition, there is resource management related to the distribution process such as the use of electrical energy and water, periodic vehicle maintenance, and supporting tools for seedling care. The maximum capacity of seedlings that can be accommodated by the agency is around 25000 small-sized seedlings, while for large-sized seedlings it is around 15000.

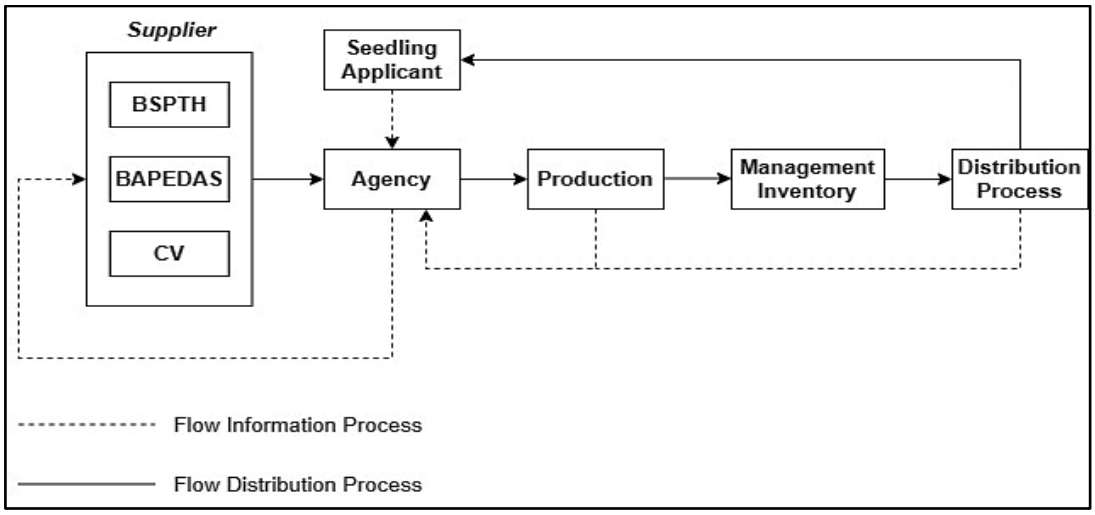

Figure 2. Supply Chain Flow of XYZ Agencies Seedling Distribution Process Based on SCM

4.2 Key Performance Indicator Hierarchy Structure

From the results of all questionnaires distributed to related respondents, 23 respondents have filled in the importance level of the KPI. Furthermore, the results of the KPI design will be presented to the agency for the collection of primary data needed in accordance with the hierarchical structure that has been formed. The KPI results obtained in the seedling distribution process by XYZ Agency are at level 3 (performance metrics) as the basis for the Supply Chain hierarchy structure. Validated KPIs will be structured into a hierarchical structure shown in Figure 3.

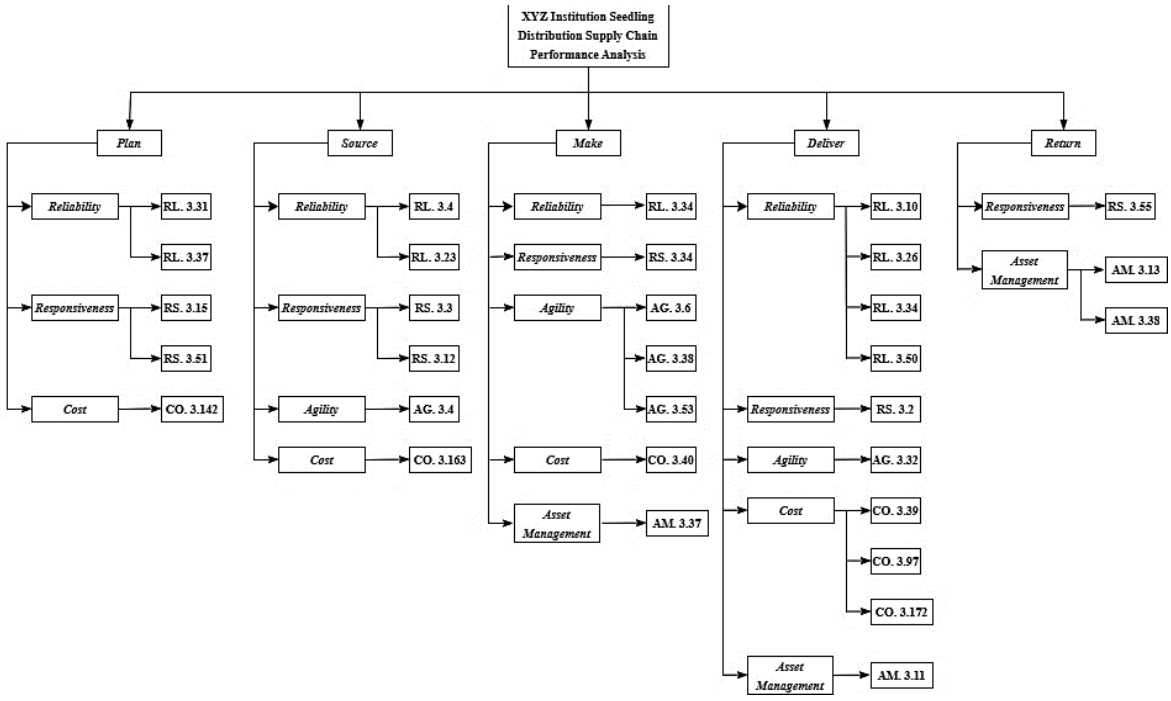

Figure 3. Hierarchical Structure Model of Seedling Distribution Process

4.3 Actual Performance Value Results

Calculation of the performance level of each indicator metric is by multiplying the value obtained from normalization with the weight of each metric from the AHP calculation. This calculation step applies to the entire SCOR model performance assessment process starting with the calculation of each level 3 metric to the overall level 1 process.

4.3.1 *Performance Metrics Final Score Results*

The SCOR level 3 calculation is done by multiplying the performance metric value with each weight according to the performance metric. The result of the performance metric calculation is a performance dimension value that is used in the next level of SCOR calculation. Table 5 explains the process of calculating performance metrics at SCOR level 3.

Table 5. Results Calculation Final Value of Performance Metrics

Process	Dimension	KPI	Score	Weight	Performance Value	Total Dimension
Plan	Reliability	RL. 3.31	100	0,821	82,10	97,02
		RL. 3.37	83,33	0,179	14,92	
	Responsiveness	RS. 3.15	83,33	0,366	30,50	85,98
		RS. 3.51	87,5	0,634	55,48	
	Cost	CO. 3.142	100	1,000	100	100
Source	Reliability	RL. 3.4	100	0,726	72,60	98.96
		RL.3.23	96,21	0,274	26,36	
	Responsiveness	RS. 3.3	80	0,366	29,28	74.56
		RS. 3.12	71,42	0,634	45,28	
	Agility	AG. 3.4	88,88	1,000	88,88	88,88
	Cost	CO. 3.163	100	1,000	100	100
Make	Reliability	RL. 3.14	83,34	1,000	83,34	83,34
	Responsiveness	RS. 3.34	85,71	1,000	85,71	85,71
	Agility	AG. 3.6	77,96	0,333	25,96	73,77
		AG. 3.38	83,56	0,333	27,83	
		AG. 3.53	60	0,333	19,98	
	Cost	CO. 3.40	100	1,000	100	100
	Asset Management	AM. 3.37	77,1	1,000	77,10	77,10
Deliver	Reliability	RL. 3.10	71,02	0,135	9,59	96,09
		RL. 3.26	100	0,236	23,60	
		RL. 3.34	100	0,156	15,60	
		RL. 3.50	100	0,473	47,30	
	Responsiveness	RS. 3.2	66,66	1,000	66,66	66,66
	Agility	AG. 3.32	28,57	1,000	28,57	28,57
	Cost	CO. 3.39	100	0,200	20	60,37
		CO. 3.97	75	0,200	15	
		CO.3.172	42,28	0,600	25,37	
	Asset Management	AM. 3.11	100	1,000	100	100
Return	Responsiveness	RS. 3.55	66,66	1,000	66,66	66,66
	Asset Management	AM. 3.13	66,66	0,500	33,33	60,53
		AM.3.38	54,4	0,500	27,20	

4.3.2 *Performance Dimensions Final Score Results*

SCOR level 2 calculation is done by multiplying the performance dimension value obtained from the previous SCOR level calculation with each performance dimension weight. The result of performance dimension calculation is a performance process value that is used in the final SCOR level calculation. Table 6 explains the process of calculating performance dimensions at SCOR level 2.

Table 6. Calculation Result of Final Dimension Value

Process	Dimension	Score	Weight	Performance Value	Total Process
Plan	Reliability	97,02	0,413	40,07	94,29

Process	Dimension	Score	Weight	Performance Value	Total Process
	Responsiveness	85,98	0,327	28,12	
	Cost	100	0,260	26,00	
Source	Reliability	98.96	0,298	29,49	90,4
	Responsiveness	74.56	0,300	22,37	
	Agility	88,88	0,140	12,44	
	Cost	100	0,261	26,10	
Make	Reliability	83,34	0,230	19,17	83,88
	Responsiveness	85,71	0,252	21,60	
	Agility	73,77	0,192	14,16	
	Cost	100	0,170	17	
	Asset Management	77,10	0,155	11,95	
Deliver	Reliability	96,09	0,153	14,70	68,57
	Responsiveness	66,66	0,240	16	
	Agility	28,57	0,225	6,43	
	Cost	60,37	0,168	10,14	
	Asset Management	100	0,213	21,30	
Return	Responsiveness	66,66	0,250	16,67	62,07
	Asset Management	60,53	0,750	45,40	

4.3.3 *Supply Chain Performance Final Score Measurement*

SCOR level 1 calculation is done by multiplying the performance process value obtained from the SCOR level 2 calculation with each performance process weight. The result of the final calculation of the performance process is an actual performance process value that shows the performance value of the distribution process performed by XYZ Agency. Table 7 explains the process of calculating the actual performance process at SCOR level 1.

Table 7. Final Result of Actual Performance Process Supply Chain Value

Process	Score	Weight	Final Value
Plan	94,29	0,164	15,46
Source	90,4	0,255	23,05
Make	83,88	0,260	21,81
Deliver	68,57	0,156	10,70
Return	62,07	0,195	12,10
Total			83,12

5 Conclusion

The seedling distribution process at XYZ Agency is categorized according to the SCM concept. The identification of each seedling distribution process is divided into the plan, source, make, deliver, and return processes. The grouping of processes according to the SCM concept related to distribution process planning starts from the procurement of seedling sources, selection of seedling suppliers, seedling care processes and asset management. This is done as a structured distribution process breakdown and consideration of improving the performance process in accordance with the SCM concept in XYZ Agency. Based on the results of the calculation of the entire series of processes from the SCOR model, the final score on the performance process of the distribution of plant seeds by XYZ Agency is 83.12. The process performance results show they are in the good category. Each of the final calculation results has an influence on the supply chain process with the highest performance value, namely source of 23.05 so it needs to be sustained. The lowest performance value is in the deliver process with a value of 10.70 so that there is a need for improvement regarding the process.

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