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Analysis of the Effectiveness of the Machining Equipment Supply Chain Network Using the Supply Chain Operation Reference (SCOR) and Analytical Hierarchy Process (AHP) Method at Industrial Equipment Supplier Companies

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Abstract

Background: Supply chain is very important for the sustainable development of an industry. At all scales, they must be able to run and develop their business supply chains well to achieve good sustainability. Because operations at all scales are unrestricted and the structure is complex, the complexity of implementing the supply chain model is also very complex. Supply chain performance measurement will greatly assist supply chain operations and development. The purpose of this study is to analyze the causes of supply chain flow obstruction and improve supply chain performance.
Methods: The method used in measuring supply chain performance is the SCOR and AHP methods with the help of expert choice software. The measurement of supply chain performance obtained in the study is that there are 43 indicators.
Result: Based on the research results, the company's supply chain performance indicators that need improvement and are prioritized are the indicators that get the lowest score. From the results of data processing, the level of importance of the existing criteria is at level 1 which is deliver with a weight of 1.89, level 2 is cost with a weight of 1.46, and level 3 is DC1 (message cost management) with a weight of 0.75. Based on the results of the analysis, the advice given is to better manage the management of each order cost that will be ordered for the entire supply chain chain to be more effective.

Keywords: AHP, SCOR, Software Expert Choice, Supply Chain Management.

1. Introducting

In the era of globalization, business competition is no longer price and product competition. Only companies with reliable supply chain management can survive and win in the market competition. The quality of listening to consumer desires will also have an impact on service quality (Nicolae et al., 2012). Consumers are increasingly critical of their demands in terms of providing products in the right place, in the right quantity and quality, and at the right time. In addition, Pujawan in Sherlywati (2018) said that the complexity of the supply chain, and the uncertainty factor are also problems that must be faced by companies. In addition, it is said that the complexity of the supply chain is caused by the many parties involved, each of which has its own objectives which often conflict with each other (*objective conflict*). As for the uncertainty factor, there are three main sources of uncertainty in the supply chain, namely demand uncertainty, supplier uncertainty, and uncertainty between internal parties.

The high number of imports of the machine and transportation equipment group. Due to the large volume of imports, it takes a long time to transport goods from suppliers to Indonesian distributors, because there are several obstacles in the port loading and unloading process, including *dwelling time* . and the *waiting time* (waiting*time),demurrage,* port activity supporting equipment, human resources (HR). Therefore, companies need to anticipate some of these constraints in order to optimize the supply chain network*(supplychain),*and requires the company values*(value)*to meet customer needs. This situation shows the importance of measuring performance, not only within the company, but also other parties in the*supply chain*relatedin order to compete with other companies or supply chains. If a company wants to survive in a growing and changing market environment, then the company needs to improve its performance, a performance control mechanism is needed to monitor every indicator of the company's supply chain performance, where it should also be noted that there are important performance indicators, such as the effectiveness of delivery services and operational efficiency to providing logistics transportation services. The development of national logistics is also influenced by Indonesia's economic growth. Based on data from the Central Statistics Agency (BPS), the details of economic growth in Indonesia for logistics, transportation and warehousing are as follows:

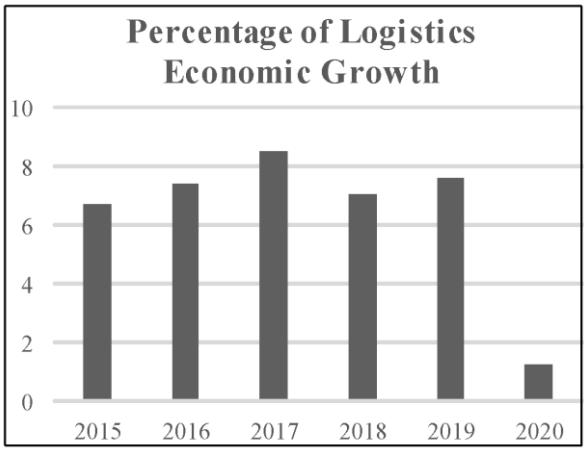


Figure 1. Graph of Economic Growth During the 2015-2020

The rate of economic growth in the 2015-2019 period fluctuated due to instabilitygoods *finished good* in the warehouse to be ready for delivery and there was a significant decline in 2020 due to the pandemic. This is very influential because the *spare parts* used for production experience delays in delivery of goods and processes are often found in the national logistics system which causes high logistics costs and low service quality.

Table 2. Recapitulation of the Number of Goods Shipments in 2020

Month	Number of Shipments (pcs)	Sent (pcs)	Delay (pcs)
Jan	355	340	15
Feb	371	356	15
Mar	275	254	21
Apr	263	242	21
May	273	247	26
Jun	245	219	26
Jul	327	298	29
Aug	345	316	29
Sep	356	329	27
Oct	336	317	19
Nov	361	343	18
Dec	372	357	15
Total	3879	3618	261

Data in table 2 is obtained from calculations carried out partially 12 times in 2020. From the above data , every month there is always a delay in the delivery of goods. Posts*(shipment)*in 2020 as many as 3879, the quantity of goods delivered*(delivery)*in 2020 as many as 3618 and the number of delays in delivery of goods in 2020as many as 261.

AHP decision-making tool that uses several variables with hierarchical analysis process is strong and flexible. AHP is an important contribution of this analysis, namely because each priority choice can be structured or composed according to the criteria, so that priority setting is based on a structured (hierarchical) process and makes sense. AHP helps solve complex problems by compiling a hierarchy of criteria, assessed subjectively by interested parties and then draws various considerations in order to develop weights or priorities (conclusions).

Previously, the company did not conduct a comprehensive performance assessment which indicated that the company could not determine the factors that greatly affect theflow *supply chain* that needed improvement. With this research using the *Supply Chain*

Operations Reference (SCOR) and the *Analytical Hierarchy Process* (AHP), the company can find out the cause of theflow obstruction *supply chain.*
Based on the description above, this research is about "Analysis of the Effectiveness of theNetwork *Machining Equipment* with theMethods at *Supply ChainSupply Chain Operation Reference* (SCOR) and *Analytical Hierarchy Process* (AHP)Companies *Industrial Equipment Supplier* in Jakarta".

2. Theoretical Review

Performance measurement is one of the key elements in *supply chain* effectivemanagement (Trasewicz, 2016). According to Nisa, (2019), performance measurement is a process of planning, controlling **which** aims to determine the contribution of a part or team in the company and provide motivation for all parts of the company. *Supply chain* is a network of companies that work together to create and deliver a product to the end user (Pujawan and Mahendrawati, 2010). The term *supply chain management* was first proposed by Oliver and Weber in 1982. *Supply Chain Management* is a complete business process in the form of a cycle starting from raw materials from suppliers to factories to distribution activities to consumers. SCM performance measurement is very important to reduce costs, meet customer satisfaction and increase company profits and to find out how far theperformance *supply chain* company'shas been achieved (Setiawan et al., 2020).
In the concept of *Supply Chain Management, a* series of activities between suppliers and final consumers is a single unit without big barriers. The information mechanism between the various components takes place in a transparent manner. The main principle in *Supply Chain Management* is sharing (*sharing*) the flow of material, the flow of information that combines all elements in the supply chain (Natalia & Astuario, 2015).
According to Nur Handayani & Noor, (2018), SCOR is a reference model of process-based supply chain operations. SCOR is able to map parts of the *supply chain*. SCOR dividesprocesses *supply chain* into 5 core processes, namely *plan, source, make, deliver, and return.* Ramadhan, et al., (2019).
AHP is a decision support model developed by Thomas L. Saaty. This decision support model will describe *multi-factor* or *multi-criteria problem* a complexinto a hierarchy. AHP is a process of systemic rationality, with AHP it is possible to consider a problem as a whole and examine the simultaneous interaction of various components that are arranged in a hierarchical manner so that it is easy to understand and analyze (Rimantho et al., 2016). The main tool of AHP is to have a functional hierarchy with the *input* mainbeing human perception. AHP has the advantage of being able to combine objective and subjective elements of a problem.

3. Method

SCOR model can basically map all parts of the supply chain. SCOR divides supply chain processes into five core processes, namely plan, source, make, deliver, and return. The SCOR model is used in the design of a process-based supply chain performance evaluation system, so that companies can comprehensively evaluate the performance of their supply chain activities for monitoring and control, and communicate company goals to related businesses and supply chain functions. Companies can also use the SCOR model to determine the company's position relative to competitors and seek improvement directions to create a competitive advantage. Good performance of the supply chain will certainly be able to increase customer satisfaction and achieve the company's goal of producing valuable products and optimizing profitability.
This research includes qualitative and quantitative research types. Qualitative research method is a method for investigating objects that cannot be measured by numbers or other precise measurements. Qualitative research will be used when extracting information regarding the suitability of theperformance assessment *supply chain* in the company. On the other hand, quantitative research will be used when establishing aperformance evaluation framework *supply chain* using the SCOR and AHP methods.
To get the results as expected, and go according to plan, it is deemed necessary to carry out a process of making clear research steps. The research flowchart can be seen in Figure 2.

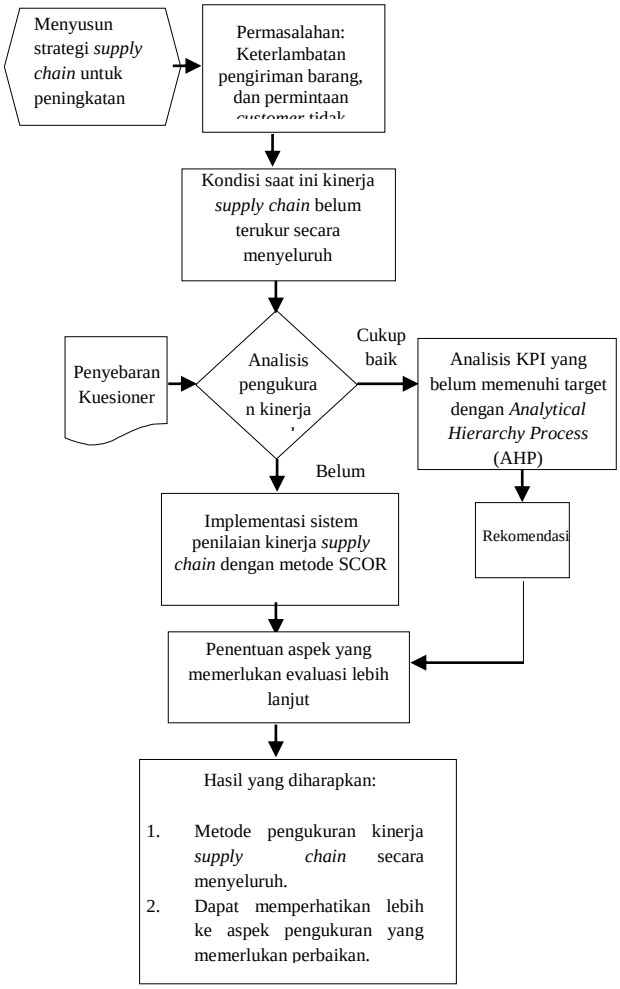


Figure 2 Flowchart

4. Data Processing and Analysis

Object of the research is an *industrial equipment supplier company* that has a vision of "becoming a leader in the field of professional industrial equipment by providing quality products and better after-sales service", based in Jakarta. This company is a *supplier* of several companies engaged in the metal, electricity, automotive, mining, and oil and gas sectors. The products offered by the company are lifting, cutting, *bevelling, rinding*, welding, drilling, *punching, bending, fastening*, and related products. *Brands* available are kobewel, kobecut, alfra, DACH, AGP, milwaukee, knipek, daichi, welking, siliconi, protec, migatronik, neutric, kemppi, jinda, i-prix, eibenstock, binzel, trafimet. The number *brands* of availableis the main attraction for companies for companies to provide many choices to *customers.*

4.1. Data Processing

4.2. Supply Chain Performance

Measurement This supply chain performance measurement uses the Supply Chain Operation Reference (SCOR) model approach. In the early stages of this research, data collection begins with the details of the activities (from general to more detailed) in the SCOR model. The description of the hierarchy is as follows:

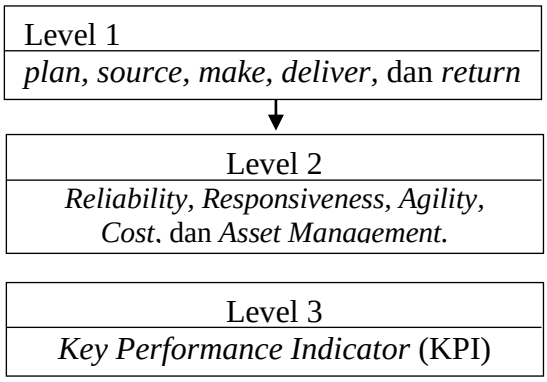


Figure 3. Description of performance measurement with the SCOR Model

At level 1 which includes 5 perspectives, namely plan, source, make, deliver, and return using the indicators in it which will be used at level 2 to identify attributes -Company performance attributes.

a. Plan, in this process is planning in the distribution process from upstream to downstream including product inventory planning activities and marketing plans. By making good planning, the process will make the supply chain process effective, efficient and productive.

b. Sourcing, in this process, the process of procuring products to meet market demand. These activities include planning supplier selection, scheduling product delivery from suppliers and transportation, receiving, inspection, inventory management and official payments for products shipped by suppliers. The problem is that suppliers cannot provide products due to sudden consumer demand.

c. Make, this process includes the condition of the product at the time of receipt and delivery, such as controlling product quality, speed of handling part damage, maintaining production facilities, paying attention to internal product stock limitations, and product packaging processes according to customer requests.

d. Deliver, this process includes activities related to the accuracy of product delivery to customers, delivery of products to suppliers in the event of a product error, product marketing to customers, product loading, the process of checking order requests, handling activities in the warehouse and making invoices to customers (payments).

4.3. Designing Key Performance Indicators (KPI)

Design of *Key Performance Indicators* (KPI) as benchmarks used in performance appraisal which is an indicator at level 3 in the SCOR model matrix. The design of KPIs in this study was made through a process of interviews and discussions with the company based on references from literature research to find out the KPIs that have been prepared in accordance with existing conditions.

Kriteria	R1	R2	R3	R4	R5	R6	R7	**Kriteria**	**Geomean**
A1	3	3	0,2	1	0,14	3	7	B1	1,269
A1	3	3	1	0,33	5	3	0,13	C1	1,285
A1	0,2	1	3	3	0,2	5	0,33	D1	0,928
A1	1	0,33	0,33	1	3	0,2	1	E1	0,677
B1	0.2	0,33	1	1	3	5	2	C1	1,465
B1	0.2	1	2	3	2	1	5	D1	1,979
B1	0.25	0.14	1	3	3	3	1	E1	1,933
C1	0.14	0.25	0,33	0,33	0,33	3	7	D1	0,945
C1	0,25	3	1	0,33	0.2	0.33	0.14	E1	0,705
D1	0,33	1	1	0,25	1	3	0.33	E1	0,792

Performance indicators are classified according to supply chain activities in the SCOR model, with five core processes, namely *plan, source, make, deliver,* and *return.* In each process there are 5 main indicators that need to be considered, namely *reliability* (reliability), *responsiveness* (responsiveness), *agility* (agility), *cost* (cost) and *asset management* (asset management). Based on the results of determining the *key performance indicators* above, the results obtained are 43 KPI indicators (before being selected) and the results have been selected as many as 23 KPI indicators, namely as follows:

Matrix of Selected Indicators			
Perspektive	Level 1	Level 2	Level 3
Reliability	A1	A11	A121

		A12	A141
		A14	
Responsiveness	B1	B11	B111
		B12	
	C1	C12	C111
Agility		C13	C121
			C131
	D1	D11	
Cost		D12	
		D13	
Asset Management	E1	E12	E121

Table 3 Determination of KPIs

(Source: Data Processing Results, 2021)

4.4. Method *Analysis Hierarchy Process* (AHP)

Weighting of criteria is carried out on the KPI matrix of 5 perspectives, namely, *Reliability*, *Responsiveness*, *Agility*, *Cost*, and *Asset Management.* The weight of the perspective criteria is filled by 7 respondents who are considered *experts* on the company's supply chain. The questionnaire used is a pairwise comparison matrix questionnaire. The results of the recapitulation of the pairwise comparison questionnaire can be seen in table 4

Level-1

Kriteria	R1	R2	R3	R4	R5	R6	R7	**Kriteria**	**Geomean**
A1	3	3	0,2	1	0,14	3	7	B1	1,269
A1	3	3	1	0,33	5	3	0,13	C1	1,285
A1	0,2	1	3	3	0,2	5	0,33	D1	0,928
A1	1	0,33	0,33	1	3	0,2	1	E1	0,677
B1	0.2	0,33	1	1	3	5	2	C1	1,465
B1	0.2	1	2	3	2	1	5	D1	1,979
B1	0.25	0.14	1	3	3	3	1	E1	1,933
C1	0.14	0.25	0,33	0,33	0,33	3	7	D1	0,945
C1	0,25	3	1	0,33	0.2	0.33	0.14	E1	0,705
D1	0,33	1	1	0,25	1	3	0.33	E1	0,792

Table 4 Recapitulation of Pairwise Comparison Values of All Respondents
(Source: Data Processing Results, 2021)

Table 5 Pairwise Comparison Matrix

	A1	B1	C1	D1	E1
A1	1,000	1,269	1,285	0,928	0,677
B1	0,788	1,000	1,465	1,979	1,933
C1	0,778	0,682	1,000	0,945	0,705
D1	1,077	0,505	1,058	1,000	0,792
E1	1,477	0,517	1,418	1,262	1,000
Total	5,120	3,974	6,226	6,114	5,108

(Source: Data Processing Results, 2021)

Table 6 Matrix Normalization

	A1	B1	C1	D1	E1	Number of Rows
A1	0,195	0,319	0,206	0,152	0,133	1,005
B1	0,154	0,252	0,235	0,324	0,378	1,343
C1	0,152	0,172	0,161	0,155	0,138	0,777
D1	0,210	0,127	0,170	0,164	0,155	0,826
E1	0,288	0,130	0,228	0,206	0,196	1,048
Total	1,000	1,000	1,000	1,000	1,000	5,000

(Source: Data Processing Results, 2021)

Priority Vector	Matriks priority	x	Concistensy
0,201	1,037		5,157
0,269	1,037		3,861
0,155	1,037		6,673
0,165	1,037		6,276
0,210	1,037		4,945
1,000			

Table 7 Concistency Test Results

Calculating CR Kriteria	
λ maks	5,38
CI	0,10
RI	1,12
CR	0,09

(Source: Data Processing Results, 2021)

In the consistency test, several calculations are carried out, namely calculating max, *Consistency Index* (CI) , *Random Index* (RI), *Consistency Ratio* (CR). If the value of CR <0.1 then the results obtained are consistent, and vice versa. From the table of results, the CR value obtained is 0.09. Then it can be stated that the test results are consistent because the results are less than 0.1.

Expert 2

Table 7 Recapitulation of Paired Comparison Values All Respondents Level-2

Kriteria	R1	R2	R3	R4	R5	R6	R7	**Kriteria**	**Geo**
A11	1	0,33	0,2	1	0,14	3	7	A12	0,791
A11	3	3	1	0,33	5	3	0,13	A14	1,285
A12	5	1	3	3	0,2	5	0,33	A14	1,470

(Source: Data Processing Results, 2021)

Table 8 Pairwise Comparison Matrix

	A11	A12	A14
A11	1,000	0,791	1,285
A12	1,264	1,000	1,470
A14	0,778	0,680	1,000
Total	3,042	2,471	3,755

(Source: Data Processing Results, 2021)

Table 9 Normalisasi Matrik

	A11	A12	A14
A11	0,329	0,320	0,342
A12	0,415	0,405	0,391
A14	0,256	0,275	0,266
Total	1,000	1,000	1,000

Jumlah Baris	*Priority Vector*	*Matriks x priority*	Concistency
0,991	0,330	0,991	3,001
1,212	0,404	0,991	2,455
0,797	0,266	0,991	3,731
3,000	0,600		

(Source: Data Processing Results, 2021)

Table 10 Consistency Test Result

Calculating CR Kriteria		
λ maks	3,06	
CI	0,03	
RI	0,58	
CR	0,05	KONSISTEN

(Source: Data Processing Results, 2021)

From the table of results, the value The CR obtained is 0.05. Then it can be stated that the test results are consistent because the results are less than 0.1. The same processing was carried out for indicators of responsiveness, agility, and cost with consistent results.

Level- 3

Table 11 Pairwise Comparison Matrix Level-3

Kriteria	R1	R2	R3	R4	R5	R6	R7	**Kriteria**	**Geomean**
C111	0,33	1	1	0,14	0,14	1	5	C121	0,612
C111	3	5	1	0,33	1	3	1	C131	1,470
C121	1	1	3	0,25	0,33	3	0,33	C131	0,818

(Source: Data Processing Results, 2021)

Table 12 Matrix Normalization

	A121	A141	Jumlah Baris
A121	0,569	0,569	1,137
A141	0,431	0,431	0,863
Total	1,000	1,000	2,000

Priority Vector	Matriks x priority	Concistency
0,569	0,948	1,667
0,288	0,948	3,296
0,400		

(Source: Data Processing Results, 2021)

Table 13 Uji Concistency

Menghitung Kriteria	CR	
λ maks	3,03	
CI	0,02	
RI	0,58	
CR	0,03	KONSISTEN

(Source: Data Processing Results, 2021)

From the table of results, the CR value obtained is 0.03. Then it can be stated that the test results are consistent because the results are less than 0.1. After all calculations are obtained, the following is a recapitulation of alltest results *Consistency Ratio* (CR)between criteria and sub-criteria on *Key Performance Indicators* (KPI) Level-1, Level-2, Level-3.

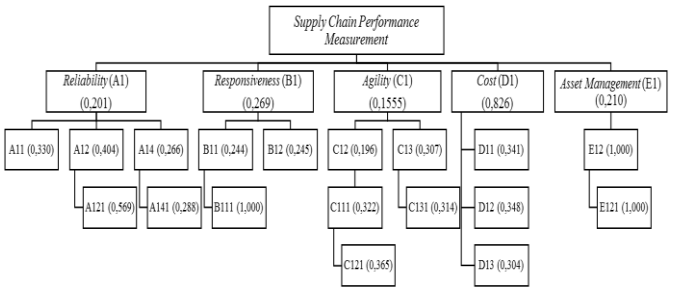
Table 14 Recapitulation of AllTest Results *Consistency Ratio* (CR)

Pairwise Comparison Between Criteria and Sub-Criteria	max	CI	RI	CR	Results
Criterion-1 (A1, B1, C1, D1, E1)	5.38	0.10	1.12	0,09	Consistent
Sub Criteria-2 *Reliability* (A11, A12, A14)	3.06	0.00	0.58	0.05	Consistent
Sub-Criterion-2 *Responsiveness* (B11, B12)	4.06	2.06	0.00	0.00	Consistent
Sub-Criterion-2 *Agility* (C12, C13)	4.15	2.15	0.00	0.00	Consistent
Sub Criteria-2 *Cost*	3.1	0.0	0.5	0.0	Consist

(D11, D12, D13)	0	5	8	8	ent
Sub Criteria-3 *Reliability*	2.4	0.4	0.0	0.0	Consist
(A121, A141)	8	8	0	0	ent
Sub Criteria-3 *Agility*	3.0	0.0	0.5	0.0	Consist
(C111, C121, C131)	3	2	8	3	ent

(Source: Data Processing Results, 2021)

Based on the results of data processing that has been obtained, the following in Figure 3 is a hierarchical arrangement of criteria and sub-criteriamethod *AnalysisHierarchy Process* (AHP) in the *framework of* determining the SCOR method for *Industrial Equipment Suppliers*



Gambar 3 Susunan Hierarki Kriteria dan Sub Kriteria AHP

(Source: Data Processing Results, 2021)

5. Conclusions and Suggestions

Based on research that has been conducted onperformance *supply chain* incompanies *industrial equipment supplier* , several conclusions can be drawn, including the following:

1. After measuringperformance *supplychain* of 4 performance processes, the results of the filtering of indicators obtained the results of 23 selected indicators from 43 initial SCOR indicators. From the research, the achievement indicators obtained by *Agility* have the highest value among all dimensions, which is worth 0.98 and is included in theperformance indicator *Excellent.* Then theindicator *Asset Management* has the lowest value among all dimensions with a value of 0.21 and is included in theperformance indicator *Average.*
2. The result of measuring the overallperformance of *supply chain* companies *industrial equipment supplier* is 1.18 or 118%, that the performance indicators are at thelevel *excellent*, which indicates that the company can make improvements to the criteria that have been studied. With the dimensions that have the lowest value, namely thecriteria *Asset Management* with a value of 21% (*poor*) so it is necessary to immediately make improvements to get the targeted performance results of 70%.

5.1 Suggestions

Based on the results of the analysis, discussion and conclusions in this study, some suggestions are given including the following:

1. This performance appraisal only assesses the matrix that is important to use in one type of company, the next step can be to add comparisons for companies in other fields. Because every company has different characteristics in terms of operations, strategy, vision-mission and performance priorities.
2. performance measurement is *Supply chain* carried out in order to have a description for the overall performance assessment of the industry or *industrial equipment supplier company.*
3. For further research, it is expected to develop indicators in measuringperformance *supply chain* that are more specific and adapted to the needs and conditions of the company. The presentation of the preparation of this research still requires improvement from various aspects. Therefore, for the development of further research for the plastic packaging industry or other industries, it can be explored again the things that need to be added to the discussion.
4. Conduct and implement the *best practice* SCOR model to overcome obstacles and problems in supply chain activities, for further evaluation of the value ofperformance measurement *Supply Chain*. This means that in *best practice the* SCOR model can be used as an illustration to make continuous improvements to theactivities *supply chain* company's.

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