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RESEARCH PAPER

Supply Chain Performance Measurement and Improvement for Forging Industry

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ABSTRACT

Forging Industry supply chain involves various actors and acts as Industry Intermediate providing various products for downstream industrial customers. This study aims to analyze supply chain performance and recommend improvement strategy at forging Industry. This study applied supply chain operation reference (SCOR) and analytical hierarchy process (AHP) to analyze supply chain performance. A SWOT analysis was applied to improve supply chain performance. The data was validated at ABC co. and XYZ co. as two focal company in supply chain operations of forging industry. Supply chain performance measurement at ABC co. show the performance was 99.42% (excellent) and 99.05% (excellent) in 2019 and 2020, respectively. Supply chain performance score at XYZ co. showed 96.60% (good) and 97.52% (good) in 2019 and 2020, respectively. This study has succeeded in formulating efforts to improve the supply chain performance with SWOT analysis that extracted from the performance measurement analysis, field observation and in-depth interview. The suggested strategies were producing quality goods according to domestic market specifications, maintaining good relations with suppliers or outsourcing, improving services using high technology.

KEYWORDS: *Forging industry; Supply chain; Performance; Analytical hierarchy process; Strategy.*

1. Introduction

Strengthening the development of the automotive industry (safety riding), heavy equipment, construction in the middle of this pandemic period is necessary in conducting business sustainability. An agile and adaptive strategy in automotive industry is needed to meet consumer demands and achieve supply chain goals to access high performance in strategic and operational [1], [2]. In this context, supply chain has a key role in dealing with the current situation. Therefore the demand for increasing productivity, value-added activity and services is needed in global competition and very tight the purpose is for the sustainability of the company itself [3], [4].

Challenges and competition in the business environment provides consumers to have many choices to decide which products to buy in meeting the needs. Industry must improve competitiveness to survive with the uncertain environment with an appropriate decision-making process and planning [5]. In this context, industry must define goals and evaluate current performance to formulate strategy to meet consumer demands and achieve profits [6]–[9]. Refer to [10], a strategy aims to find a way in producing goods and services that meet the requirements of the customer in the limits of cost and other managerial limitations. A wrong strategy in supply chain to be applied in a business process will have a major impact on the costs and trust from consumer that incurred by the company [11]. For this reason, it is necessary for companies to analyze production activities, supply chain performance and relations to externals stakeholder to achieve company goals and requirements.

Supply chain at forging industry is complex since it needs a proper planning in purchasing raw materials that required minimum of 3 months of bookings. After the process of ordering the material then management need to set the production process and distributes

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products to respective consumers. In this case, the performance of the supply chain plays a role in guaranteeing the company's competitiveness, controlling variables and monitoring stakeholder business process. Along supply chain activities must assisting in produce and distribute a value-added and high-quality product to meet consumer demands [12]. In this case, supply chain performance measurement may applied drivers and attributes that adopted from internal and external supply chain operations [7], [13], [14]. A low supply chain performance in attributes and drivers had a significant effect on profitability which was proxied with net profit margins.

This study adopts a performance measurement framework based on five core business processes on the supply chain operation reference (SCOR), including: plan, source, make, deliver and return [15]. The SCOR model is enables industry to describes the supply chain in detail, defines and categorizes processes and define performance measurement indicators in analyzing the supply chain performance [16]. SCOR for supply chain performance measurement has been applied in many sectors, including agroindustry [7], [17], automotive [18], and textile industry [19], [20]. In this study, the SCOR framework is combined with analytical hierarchy process (AHP) to analyze supply chain performance, as seen in previous research that applied in various industries and sectors [7], [14], [21], [22].

ABC co. and XYZ co. are two forging industry company that has been established more than 15 years and experiencing in dynamism of any supply chain condition. Forging industry is classified as an automotive industry that must provide the best quality and productivity of components as intermediate industry in fulfilling downstream stakeholder. The forging Industry produces products that made of iron or aluminum for automotive industry. Forging means the workpiece deformation process which is pressed between two molds (die) with shock or gradual pressure.

The forging industry needs an extremely prominent level of precision so that the production process and quality must be controlled to achieve a satisfying supply chain performance with high quality product as consumer demand. The forging industry is always trying to conduct the supply chain process optimally but, it found issues which affect product quality, consumer trust and supply chain performance. Several internal factors affect supply chain performance including supply chain planning, raw material purchasing and quality and production scheduling. Related to attributes in supply chain performance using SCOR, internal factors including cost and asset management while external are reliability, responsiveness and agility [14]. To manage issues related to supply chain management performance and competitive advantages, the internal and external factors must be identified and solved [23].

At present the forging industry face with the problem in conducting business processes with dynamic change in demand that affect the number of raw material orders to suppliers. This issue affects many problems, including defective raw materials, long time delivery of raw materials to companies, costumer satisfactions and number of products returns. Therefore, a study was conducted for the performance measurement of the forging industry supply chain with the SCOR 11.0 model approach and analytical hierarchy process. The contribution of this study is expected to be able to help the industry to control supply chain performance in the face of competition in achieving competitive advantage with high quality products and manage costumer demand.

Further, this study wants to answer the following research questions: how the supply chains performance of the forging industry and how to improve the performance? This study aims to analyze performance and formulate efforts to improve the performance of the forging industry supply chain. The SCOR-AHP approach is implemented for performance analysis. The results of the performance analysis are the basis for the formulation of efforts to improve the supply chain performance.

2. Research Methodology

This research was conducted at the forging industry in Indonesia by collecting research data in two companies, namely ABC co. and XYZ co. The focus of the study is the supply chain performance of forging industry and provide performance improvement strategy. For the supply chain performance, this study applies the combination of supply chain operations references (SCOR) and analytical hierarchy process (AHP). SWOT analysis is applied by identifying the weakness and strength of the supply chain based on supply chain performance analysis. The research stage is illustrated at Fig.1.

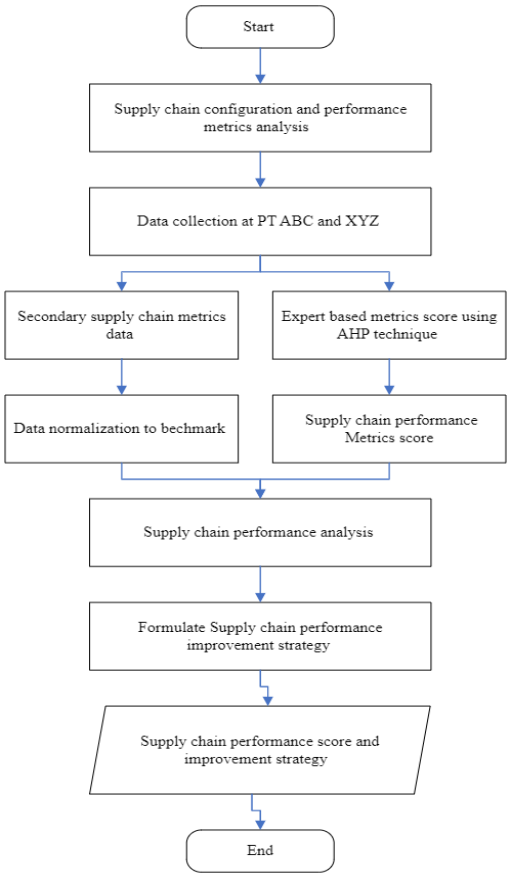

Fig. 1. Research stage for supply chain performance measurement and improvement

2.1. Supply chain metrics

In the supply chain performance analysis, metrics are required to analyze the performance. This study adopted supply chain performance metrics from supply chain operation reference (SCOR) [15]. Supply chain performance metrics that analyzed in this study are provided at Table 1.

There are twenty-one supply chain metrics to evaluate forging industry performance. These metrics are decomposed by five SCOR attributes. Further, According to [22] and [14] supply chain performance metrics has characteristic and the level of importance for specific business process. Scholars argue to involve expert in providing the weight of supply chain metrics.

Tab. 1. Supply chain metrics and target

No	Attribute	Metrics	Unit	Target
1	Reliability	On time raw material delivery	%	+
2		Dies making and repairing performance	%	+
3		Production cycle time performance	%	+
4		Preventive maintenance performance	%	+
5		Time to managing consumer complaints	Days	-
6		Number of costumer orders	%	-
7		Number of requests for price quotes	%	+
8	Responsiveness	Number of shipping goods to customer	%	+

9		Quality of raw materials	%	+
10		Number of internal rejection achievement	%	-
11		Outsources supplier performance	%	+
12		Customer satisfaction	%	+
13	Agility	Achievement in product procurements	%	-
14		Number of successful delivery order	%	+
15		Employee skill improvements	%	+
16		Customer goods return	%	-
17	Cost	Predictive maintenance cost	$	-
18		New product development cost	$	-
19	Aset	Raw material turnover	%	+
20	management	Prediction accuracy in inventory	%	+
21		Inventory management performance	%	+

2.2. Supply chain performance measurement

In the first stage in performance measurement, we determine the metrics weight using analytical hierarchy process (AHP). An AHP methodology which proposed by [24] is applied to find supply chain metrics weighted score. The supply chain performance attributes and metrics are organized into a hierarchy to find the weighted score with expert judgement. Five expert judgements from academician and practitioner participate in this stage to find a consistent and valid metrics score using AHP.

To find the weight of the metrics in performance measurement using AHP, a hierarchy is required. In this case, the hierarchy for supply chain performance measurement in forging industry is depicted at Fig. 2. The basic idea to find metrics weight using AHP is to apply a pair-ways comparison. The elements in AHP are compared using a relative measurements with scale 1 – 9 [25]. Supposed that Ai is an element in AHP in the same level. The pair-ways comparison to find weight of the elements is illustrated at Table 2.

All Experts contribute judgements and generate it using a geometric mean. To ensure the validation of the expert judgement, a consistency ratio (CR) is evaluated. Expert score in CR must be below 10% to ensure the judgement is valid.

Tab. 2. Pair-ways comparison illustration

Elements	A_1	A_2	…	A_I
A_1	1	A_1/A_2	…	A_1/A_I
A_2	A_2/A_1	1	…	$A2/A_I$
…			…	
A_I	A_I/A_1			1

Each supply chain metrics are identified and collected data from secondary data. SCOR find metrics score with compare the real data to the benchmark data. To find the metrics score, each metrics must be identified its target with positive or negative dimensions. Suppose that *Si* is performance for metric *i, Smin and Smax* as minimum and maximum performance data for metric *i*, and *Bi* as benchmark for metrics *i*, therefore according to [26], to find metrics *i* score is described at Equation (1) and (2).

$$Metrics\ score\ for\ minimum\ target\ (M_i^-) = \frac{S_i - S_{min}}{B_i - S_{min}} \quad (1)$$

$$Metrics\ score for\ maximum\ target\ (M_i^+) = \frac{S_{max} - S_i}{S_{max} - B_i} \quad (2)$$

Measuring supply chain performance score of the forging industry is determined by the combination of weighted score of metrics that obtained by AHP and supply chain metrics performance that obtained by secondary data and normalized using Eq. 1 and 2. Therefore, suppose that W_i as weighted score of metrics i and M_i as metrics score compared to benchmark, then supply chain performance score for stakeholder j (P_j) is described at Equation (3).

$$P_j = \sum_{i=1}^{n} W_i \times M_i \quad (3)$$

2.3. Supply chain performance improvement

Formulation of the supply chain performance strategy is the process of preparing future steps after supply chain performance analysis. A lower performance of specific supply chain metrics offers a great opportunity for future improvements. In this case, the strategy formulation for supply chain performance improvement applying a simple strength-weakness-opportunity-threats (SWOT) analysis as is refer to [10], [21]. Below are steps in formulating the strategy for supply chain performance improvement at forging industry.

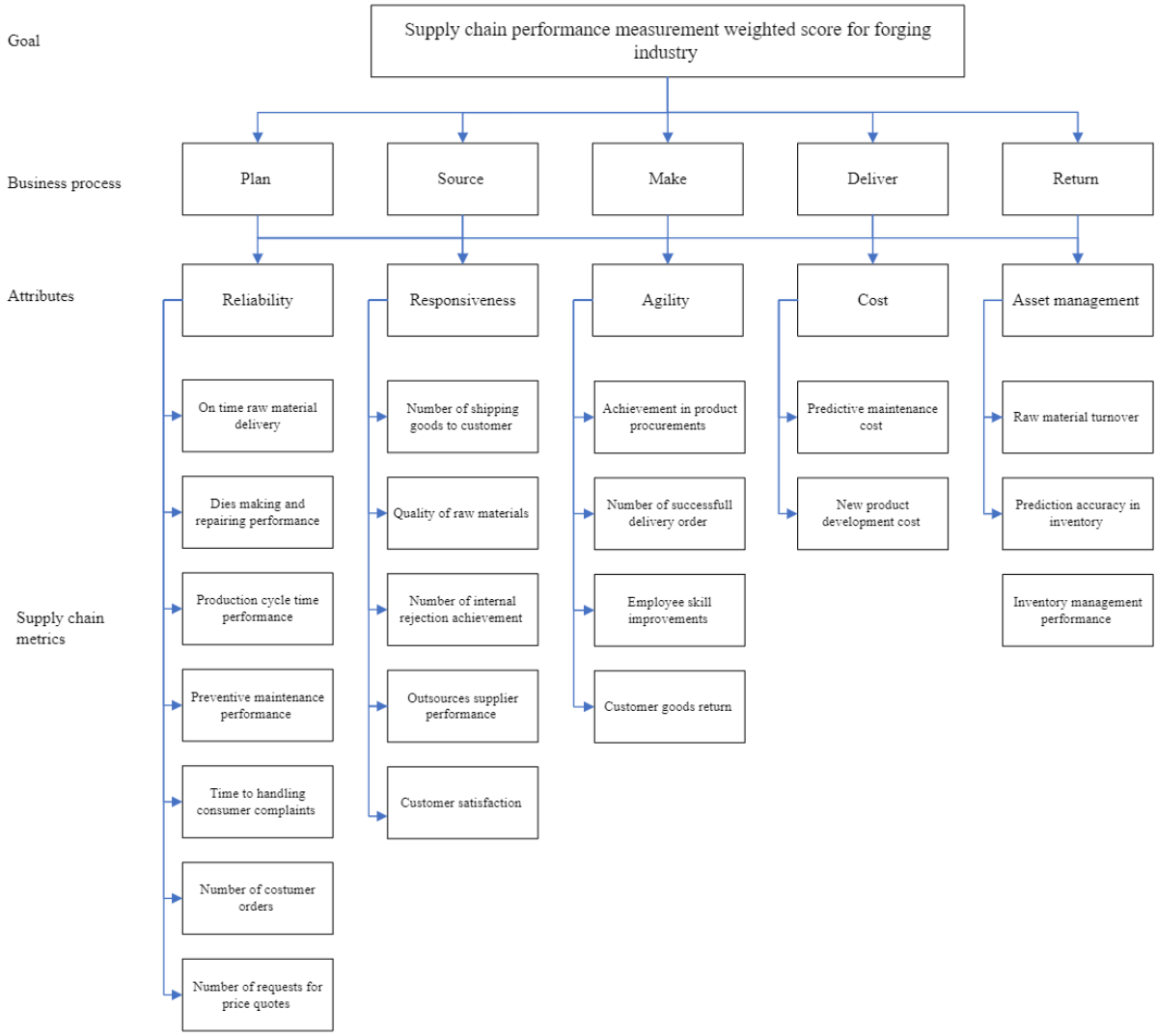

Fig. 2. Supply chain metrics hierarchy for supply chain performance metrics weight

1. The environment that will be entered and determine the company's mission to achieve a vision that has been made.
2. Conduct an internal and external environmental analysis to measure strengths and weaknesses and

opportunities and threats that will be faced by an organization in carrying out its mission.
3. Formulate the size factors of the success (Key Success Factors) of strategies designed based on previous analysis.
4. Determine measurable goals and targets, evaluating various alternative strategies by considering the resources owned and external conditions faced.
5. Choose the most suitable strategy to achieve short-term and long-term goals.

2.4. Data collection

To answer the research objective, this research collects primary and secondary data. Primary data was obtained through interviews or questionnaires from several experts in the field of forging industry, especially experienced experts in the field of forging (three experts) and then one expert from academician, one expert from government. In Table 3 is a list of experts who are asked for opinion and judgements related to supply chain performance measurement through questionnaire and in-depth interview.

Secondary data are obtained from field observation to find supply chain metrics performance in forging industry. For a comparison, we collected data from ABC co. and XYZ co. The secondary data are also obtained from several literature studies, article publications and publications of survey institutions related to the criteria that have been determined at the initial goal.

Tab. 3. Experts involving in the study

No	Background	Expertise	Number
1	Practitioners	Experienced expert in forging industry business process	1
2	Practitioners	Experienced field practitioners in the field of forging production and sales	2
3	Academician	Experienced expert in supply chain and Industrial engineering	1
4	Government	Expert staff in industrial regulations and business	1
Total			5

3. Result and Discussion

3.1. Supply chain configuration and metrics at forging industry

Supply chain configuration is the first stage to begin the analysis in supply chain environment research to know current condition [27], [28]. At the supply chain, forging industry acts as the intermediate industry that provided materials for costumer. We analyze the forging industry in this supply chain model since it is act as focal company that contributes most of the efficiency and effectiveness in supply chain [29], [30]. The supply chain configuration of forging industry is showed at Fig. 3.

Related to supply chain performance, this research adopt supply chain metric that organized by Ref. [15]. In this study, despite the operations in supply chain of the industry, we also add metrics to fully capturing supply chain flow. To find the supply chain performance score, the supply chain metrics need to weighted using AHP. Five experts from practitioners, academician and government participate in the study.

For example, to calculate weighted score of the elements in AHP provided in Fig. 2, we provide an example for business process level. Five experts have provided score for elements in business process level as shown in Table 4-8.

Tab. 4. Experts 1 judgement for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	3.000	5.000	5.000	3.000
Source	0.333	1.000	3.000	7.000	7.000
Make	0.200	0.333	1.000	5.000	3.000
Deliver	0.200	0.143	0.200	1.000	5.000
Return	0.333	0.143	0.333	0.200	1.000

Tab. 5. Experts 2 judgement for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	1.000	3.000	1.000	3.000
Source	1.000	1.000	1.000	1.000	5.000
Make	0.333	1.000	1.000	1.000	3.000
Deliver	1.000	1.000	1.000	1.000	5.000
Return	0.333	0.200	0.333	0.200	1.000

Tab. 6. Experts 3 judgement for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	5.000	1.000	1.000	5.000
Source	0.200	1.000	1.000	3.000	5.000
Make	1.000	1.000	1.000	3.000	5.000
Deliver	1.000	0.333	0.333	1.000	5.000
Return	0.200	0.200	0.200	0.200	1.000

Tab. 7. Experts 4 judgement for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	1.000	5.000	3.000	1.000
Source	1.000	1.000	3.000	3.000	5.000
Make	0.200	0.333	1.000	1.000	1.000
Deliver	0.333	0.333	1.000	1.000	1.000
Return	1.000	0.200	1.000	1.000	1.000

Tab. 8. Experts 5 judgement for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	5.000	3.000	3.000	5.000
Source	0.200	1.000	3.000	3.000	5.000
Make	0.333	0.333	1.000	3.000	5.000
Deliver	0.333	0.333	0.333	1.000	5.000
Return	0.200	0.200	0.200	0.200	1.000

All perspective of the expert in this case should be accommodated to define the weighted score of elements. In this case, using a geometric mean of five expert judgements is shown at Tab. 9. Further, using matrix multiplications and normalization technique, the final weighted score of the elements for business process level elements in AHP is shown in Tab. 10.

All AHP level and elements using the same procedure which regards to [31]. Attributes and metrics elements are also calculated, and it found the final weighted score at Tab. 11. Finally, the overall consistency is 0.05 which is confirmed that experts has provide a valid and consistent judgement based on experience and knowledge.

Tab. 9. Judgement mean for business process level

	Plan	Source	Make	Deliver	Return
Plan	1.000	2.371	2.954	2.141	2.954
Source	0.422	1.000	1.933	2.853	5.348
Make	0.339	0.517	1.000	2.141	2.954
Deliver	0.467	0.351	0.467	1.000	3.624
Return	0.339	0.187	0.339	0.276	1.000

Tab. 10. Matrix multiplications and final weight

	Plan	Source	Make	Deliver	Return	Total	Weight
Plan	5.000	7.574	12.493	18.188	35.077	78.332	0.372
Source	4.641	5.000	8.255	12.224	27.992	58.111	0.276
Make	2.895	3.140	5.000	7.298	17.434	35.767	0.170
Deliver	2.467	2.728	4.218	5.000	11.882	26.294	0.125
Return	0.999	1.449	2.167	2.535	5.000	12.150	0.058

Tab. 11. AHP weight of supply chain metrics

No	Level	Elements	Weight
1	Business	Plan	0.372
2	process	Source	0.276
3		Make	0.170
4		Deliver	0.125
5		Return	0.058
6	Attributes	Reliability	0.364
7		Responsiveness	0.101
8		Agility	0.217
9		Cost	0.078
10		Asset	0.054
11	Metrics	On time raw material delivery	0.078
12		Dies making and repairing performance	0.053
13		Production cycle time performance	0.128
14		Preventive maintenance performance	0.046
15		Time to managing consumer complaints	0.051
16		Number of costumer orders	0.054
17		Number of requests for price quotes	0.020
18		Number of shipping goods to customer	0.101
19		Quality of raw materials	0.093
20		Number of internal rejection achievement	0.047
21		Outsources supplier performance	0.041
22		Customer satisfaction	0.033
23		Achievement in product procurements	0.076
24		Number of successful delivery order	0.071
25		Employee skill improvements	0.024
26		Customer goods return	0.020
27		Predictive maintenance cost	0.006
28		New product development cost	0.028
29		Raw material turnover	0.019
30		Prediction accuracy in inventory	0.007
31		Inventory management performance	0.006

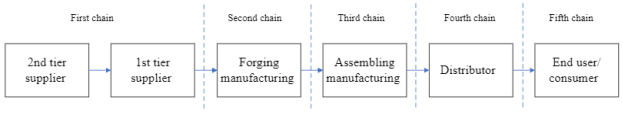

Fig. 3. Supply chain configuration and stakeholders in forging industry

Using AHP technique, it is found that for the business process in forging industry supply chain, experts agree that Plan is the most considered supply chain operations that must be pay attention. In the attribute of supply chain performance, experts are agreeing that reliability and agility as two of the most important attributes in the forging industry supply chains. It is also interpretated that external supply chain operations must be pay attention to fulfil consumer demand through an agile, reliable, and responsive operations.

3.2. Supply chain performance measurement

Supply chain performance measurement for forging industry is focus on focal company using Eq. 3. Table 4 has provided the weighted score for each supply chain metrics (W_i) which further will be adopted to measuring supply chain performance. The real data of the supply chain metrics (M_i) and its benchmark (B_i) were collected by secondary data. This study analyzes forging industry supply chain performance at two company XYZ co. and ABC co. during 2019-2020. Supply chain performance measurement result are showed at Table 12.

Supply chain performance measurement at ABC co. shows excellent performance, moreover it needs improvement on detail metrics, involving raw material delivery, number of requests for price quotes, number of internal rejection achievement, customer satisfaction, customer goods return, and employee skill improvements, prediction accuracy in inventory. These metrics shows low performance and decreasing score in 2020 compared to 2019. At XYZ co., six metrics must be pay attention, including: on time raw

material delivery, number of successful receiving orders, customer satisfaction, employee skill improvements, inventory management performance. The most important metrics considered for supply chain improvement is described at Table 13.

The result show that external supply chain metrics performance has more lower performance than internal metrics. While experts through relative measurement using AHP suggested that external metrics (reliability, agility, responsiveness) must be considered to improve performance. The analyses of supply chain performance confirm that these two companies have low performance in external attributes that need to be improved.

Our interview with the stakeholder during field observation, the lower performance of the supply chain metrics may arise by some causes and factors. This study summarizes causes that affect the lower score of supply chain metrics at Table 14.

Tab. 12. AHP weight of supply chain metrics

No	Performance metrics	(W_i)	XYZ co.				ABC co.			
			2019 (M_i)	2020 (M_i)	2019 (P_j)	2020 (P_j)	2019 (M_i)	2020 (M_i)	2019 (P_j)	2020 (P_j)
1	On time raw material delivery	0.0780	100	99.8	7.800	7.784	99.42	99.5	7.755	7.761
2	Dies making and repairing performance	0.0530	100	100	5.300	5.300	100	100	5.300	5.300
3	Production cycle time performance	0.1280	100	100	12.800	12.800	100	100	12.800	12.800
4	Preventive maintenance performance	0.0460	100	100	4.600	4.600	100	100	4.600	4.600
5	Time to managing consumer complaints	0.0510	100	100	5.100	5.100	100	100	5.100	5.100
6	Number of costumer orders	0.0540	100	100	5.400	5.400	100	100	5.400	5.400
7	Number of requests for price quotes	0.0200	90.6	83.3	1.812	1.666	100	100	2.000	2.000
8	Number of shipping goods to customer	0.1010	100	100	10.100	10.100	100	100	10.100	10.100
9	Quality of raw materials	0.0930	100	100	9.300	9.300	100	100	9.300	9.300
10	Number of internal rejection achievement	0.0470	86.6	90	4.070	4.230	88.09	80.71	4.140	3.793
11	Outsources supplier performance	0.0410	100	100	4.100	4.100	100	100	4.100	4.100
12	Customer satisfaction	0.0330	85	87	2.805	2.871	100	97.64	3.300	3.222
13	Achievement in product procurements	0.0760	100	100	7.600	7.600	100	100	7.600	7.600
14	Number of successful delivery order	0.0710	71.6	88	5.084	6.248	100	100	7.100	7.100
15	Employee skill improvements	0.0200	100	87.5	2.000	1.750	92	94	1.840	1.880
16	Customer goods return	0.0240	90	87	2.160	2.088	100	100	2.400	2.400
17	Predictive maintenance cost	0.0060	100	100	0.600	0.600	100	100	0.600	0.600
18	New product development cost	0.0280	100	100	2.800	2.800	100	100	2.800	2.800
19	Raw material turnover	0.0190	100	100	1.900	1.900	100	100	1.900	1.900
20	Prediction accuracy in inventory	0.0070	100	99.4	0.700	0.696	100	100	0.700	0.700
21	Inventory management performance	0.0060	95	97	0.570	0.582	96.93	98.97	0.582	0.594
	Performance (Pj)				96.60	97.52			99.42	99.05

Tab. 13. Supply chain metrics with low performance at Forging industry

No	Metrics	ABC co.	XYZ co.	Attribute	Department
1	On time raw material delivery	✓	✓	Reliability	Purchasing
2	Number of requests for price quotes	✓	-	Reliability	Marketing
3	Number of internal rejection achievement	✓	✓	Responsiveness	Quality control
4	Customer satisfaction	✓	✓	Responsiveness	Marketing
5	Number of successful delivery order	✓	✓	Agility	Marketing
6	Employee skill improvements	✓	✓	Agility	Human resource
7	Customer goods return	✓	-	Agility	Marketing
8	Prediction accuracy in inventory	✓	-	Asset management	Warehousing
9	Inventory management performance	✓	✓	Asset management	Purchasing

3.3. Supply chain performance improvement strategy

Previous stages have demonstrated the supply chain performance of two forging industry. Some metrics need to be managed well to improve the supply chain performance. Despite the higher performance score of the supply chain performance, ignoring the lower supply chain metrics performance led to the inefficiency and effectiveness.

These stages formulate supply chain performance improvement strategy based on supply chain performance measurement for forging industry. A simple SWOT analysis is conducted to mapping the supply chain internal and external factors in further improvements. Based on the performance measurement analysis and field observation, this study finds supply chain strength, weakness, opportunity, and threats in forging industry as described at Table 15.

Tab. 14. Supply chain metrics problems

No	Performance metrics	Causes that affect lower performance
1	On time raw material delivery	• The pandemic period affects the arrival of raw materials • Cash flow factor affects payment not fixed time
2	Number of requests for price quotes	• The pandemic period affects the delay in a request for price quotes • New product demand has decreased orders
3	Number of internal rejection achievement	• The production process is still rejected • Standard operational procedure has not been obeyed well
4	Customer satisfaction	• Customer gives an assessment of not one hundred values because there are several assessment indicators so they cannot reach 100% • Some services need to be maximized back in employee satisfaction surveys
5	Number of successful delivery order	• The pandemic period affects orders • Marketing strategy cannot find optimal product promotion using digital technology
6	Employee skill improvements	• Employee ability training needs to be improved again to improve employee capabilities • Increasing the ability of employees by conducting training must be adjusted to the work needs and age factors can affect the effectiveness of the training.
7	Customer goods return	• The production process is still rejected • Standard operational procedure has not been obeyed well • There are still some data that is not the same when Sampling Quantity Stock
8	Prediction accuracy in inventory	• There are still some data that is not the same when Sampling Quantity Stock • Management has not Consistent Treating Lot Product Identification correctly
9	Inventory management performance	• Accuracy of the data and inventory processing is still not optimal • The Stock process needs accuracy and to data across

Tab. 15. Supply chain weakness and advantages at forging industry

	STRENGTHS		WEAKNESS
S1	Complete engine capacity, high-tech	W1	Marketing is less active in capturing customers
S2	ERP system that facilitates monitor products	W2	Evaluation of customer satisfaction is not optimal
S3	High quality products	W3	Internal rejects are still high
S4	Fast in responding to customer complaints	W4	Employee skills increase are not on target
S5	Supplier performance is very good	W5	Inventory processing is still not managed properly
S6	Raw quality material awakes	W6	Checking Sampling Quantity Stock is not accurate
S7	Intime delivery is very consistent	W7	Shipping of Material Raw Material is not optimal
	OPPORTUNITY		THREATS
O1	Promising foreign market share	T1	Competitors are manufacturing forging getting tougher
O2	Candidates for European customers will divert their orders in Asia	T2	Customers open their subsidiary in forging
O3	Use technology to capture customers	T3	Competition price is very tight
O4	Services with a fast and easy digital system and efficient	T4	Alternative products are choices
O5	Industrial 4.0 is very much needed in the industrial world		

Tab. 16. Strategy improvement

Strength and Opportunity	Strategy	Weakness and threats	Strategy
SO1	Producing goods according to the international market	WT1	Marketing must be more actively promoting both exhibitions or even internet / technology and visiting
SO2	Produce quality goods according to domestic market specifications	WT2	Maintain the quality of goods by fixing the SOP again and the groove of the Quality Control process
SO3	Producing goods at ideal prices according to customer wishes	WT3	Still provide competitive prices by doing cost down without reducing quality
SO4	Maintain good relations with suppliers or outsourcing	WT4	Employee ability must be increased by re-conducting training and placing employees match with competencies and skills needed
SO5	Improve service using high technology	WT5	Managing the Work in Process (WIP) product must be increased by means of LOT in tightening, the stock of in 1 year is done twice.
SO6	Improved shipping quality by doing zero mistake deliver	WT6	Delivery of raw materials needs to improve its licensing pattern, ownership, monitoring, and arrival
SO7	Industrial 4.0 is very much needed in the industrial world		

To formulate strategy, this study confirms at field observation and invites experts to contribute to validate the results. A SWOT analysis has provided strategy based on internal and external factors that described at Table 16. Finally, this study suggests the following strategy to improve supply chain performance for forging industry:

1. Producing goods in accordance with overseas markets: Results of the interview is to produce goods that fit the company's foreign markets have emphasized the requirements and already in the work plan.
2. Producing quality goods according to domestic market specifications: Results of interviews are for the quality of measuring instruments in the Quality Control department today adequately need to increase the ability of Quality Control personnel.
3. Producing goods at ideal prices in accordance with the wishes of customer results from interviews are according to the demands of company performance and company business competition requires the presence of cost-down in all lines without reducing quality.
4. Maintaining good relations with the suppliers or outsourcing results from the interview is to go well by holding Gathering, payment on schedule and support each other.
5. Improving services using high-tech results from interviews is the company already using an ERP (Enterprise Resource Planning) system will be increased to all work processes or added new technology.
6. Improved shipping quality by doing zero mistake deliver results from interviews are need to increase the ability of all personnel specifically warehouse in accuracy, accuracy, process flow, and work reports.
7. Technology Migration to Industry 4.0 is an obligation for companies The aim is innovation, changes in the era, efficiency and convenience. Research related to industry 4.0 for forging industry has largely discussed [32], for further it needs the integration to supply chain.
8. Supply chain operations needs stakeholders' participations to provide high quality product with fast response to consumer demands. The supply chain operations is not only depend on focal company, it needs supply chain integration that including upstream and downstream stakeholder [13], [33].

4. Conclusion

This research has successfully analyzed the performance of the supply chain and formulated a strategy for improving the supply chain performance of the forging industry. This study has simulated the supply chain performance measurement at ABC co. and XYZ co. with experts' judgement and field observations. The result showed that the supply chain performance at ABC co in 2019 and 2020 are 99.42% and 99.05%, respectively. This result confirms that there was a lower performance potential at the ABC co. that must be improved. Further, the supply chain performance at XYZ co. in 2019 and 2020 are 96.60% 97.52% in 2019 and 2020.

This result confirms that XYZ co. has lower performance than ABC co. and has high potential lost in performance measurement in the future. Based on the result, this research has succeeded in proposing efforts to improve the supply chain performance for the two forging industry, including to develop strong network with suppliers and customers within customer relationship management (CRM) applied warehouse management system with industry 4.0 adoption. The strategy is extracted from the supply chain performance analysis and field observation with in-depth interview involving experienced experts.

For further research, it needs to implement the purposed strategy with cost benefit analysis and field validation.

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