Breaking the Raw Material Bottleneck: How SWARA-ARAS Method Streamlined Production for PT. Adi Satria Abadi,

by Tri Wahyuningsih

Submission date: 29-Apr-2023 03:55PM (UTC+0700)
Submission ID: 2079082082
File name: -ARAS_Method_Streamlined_Production_for_PT._Adi_Satria_Abadi.pdf (726.53K)
Word count: 4979
Character count: 23492

Breaking the Raw Material Bottleneck: How SWARA-ARAS Method Streamlined Production for PT. Adi Satria Abadi

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Abstract. This study aimed to solve the raw material management problem faced by PT. Adi Satria Abadi, a company that produces sheep and goat pikel. Although the company could meet its raw material needs from various suppliers, the quality of the raw materials did not always match the criteria. This resulted in discrepancies between the amount of production and the availability of raw materials, causing losses due to storage costs and damaged materials. To address this problem, the study integrated the Step-wise Weight Assessment Ratio Analysis (SWARA) method with the Additive Ratio Assessment (ARAS) method to prioritize suppliers. The study found that the method was effective in streamlining production, reducing storage costs, and minimizing damage to raw materials. The implication of the study is that SWARA-ARAS integration can be a useful approach for other companies to optimize their supplier prioritization and improve their raw material management.

Keywords: Raw Material Management · Supplier Prioritization · SWARA-ARAS Method · Production Optimization · Quality Control · Loss Reduction

1 Introduction

Pt. Adi Satria Abadi (PT. ASA) is a manufacturing company for the processing of animal skins and finished goods made from leather *and leather goods manufacturing* located in Manyan 1 Srimulyo Piyungan Bantul Yogyakarta. This company is engaged in the processing of animal skins or *leather* and produces products made from *leather goods (leather goods manufacturing)*. The production of this company has been sent to its domestic consumers and exported to various countries, including Italy, Korea, Japan, China, and Malaysia.

The main raw materials of PT. ASA consists of sheep pikel and goat pikel of local and imported origin. Such raw materials are divided into several levels of raw material quality. The division of *grade* levels or quality of raw materials consists of six types of

H. Ku et al. (Eds.): ICARSE 2022, ASSEHR 748, pp. 15–26, 2023.
https://doi.org/10.2991/978-2-38476-048-0_3

quality, namely kwalitet 1, kwalitet IV, kwalitet V, kwalitet VI, kwalitet VII, and kwalitet R. Monthly raw material needs of 500,000 *square-feet* have been able to be met from various *suppliers* from within the country and abroad. However, the problem that often occurs is that the raw materials received often do not match the criteria determined by the company so they have to change the *grade* or quality level of raw materials. This has an impact on causing a discrepancy between the needs of the amount of production and the availability of raw materials. There are production raw materials that are experiencing excess and on the other hand there are those that are experiencing shortages. The company suffered losses due to the accumulation of raw materials and storage costs. Vice versa, there is a shortage of raw materials and an increase in message costs. The raw materials piled up for a long time will become damaged, and they cannot be returned, while the tax will still have to be paid.

Based on the background of the problem above, the formulation of the problem from this study is how to determine suppliers in multi-criteria conditions, dynamic time with many items. This study aims to apply decision-making methods to determining the number of orders and *selecting suppliers* in multi-criteria conditions, differences in quality classification between companies and *suppliers*, and dynamic time in the raw material procurement process.

In these dynamic conditions, the determination of the priority order of *suppliers* in this study uses the development method of *the Analytical Hierarchy Process* (AHP) [1]. One of the development methods of AHP that suits the type of company is the *Step-wise Weight Assessment Ratio Analysis* (SWARA) Method [2]. This method was developed to identify the importance of the criteria and the relative weight of each criterion [3]. This method is said to be an efficient method in evaluating criteria, the SWARA Method has two important steps, namely prioritizing the criteria by involving the experts concerned and then the process of weighting the criteria [4].

The use of *Step-wise Weight Assessment Ratio Analysis* (SWARA) is for weighting criteria, while the *Additive Ratio Assessment* (ARAS) method is for determining the priority of suppliers of goat skin raw materials PT. ASA. Determination of the criteria on which the company will be considered using the evaluation of the Delphi method with the division of questionnaires [5]. The criteria used will be ranked first based on the average importance value of the criteria given by the respondent, then weighting is carried out [6]. The SWARA method was only developed to identify the weight of the criteria so it requires another MCDM method to determine the matrix of alternative ranking decisions [7]. The SWARA method is the most efficient method of weighting criteria, because this method has two important steps, namely prioritizing criteria with consideration of decision makers and the weighting process [8].

The SWARA method is the right method according to the company's conditions [9], because it is easier to use than the AHP method which involves a comparison between simpler criteria [10]. In cases involving many criteria with the AHP method, it will involve a higher number of paired comparisons [11], which negatively affects the consistency of the comparisons made, so that for the SWARA method, the comparisons carried out are much lower [12]. One method that can be integrated with the SWARA method is the *Additive Ratio Assessment* (ARAS) method which will measure quantitative factors obtained from the SWARA method [13]. The weight of the criteria obtained

will be an input in obtaining the order of priority *of suppliers* which will be calculated using the ARAS method. The ARAS method has the advantage of conducting alternatives by comparing the performance value of each alternative index with the performance value of the alternative overall index, so that more ideal results are obtained [14].

2 Research Methodology

The research method used and proceed quantitatively or qualitatively to get more explanation in the result and discussion can be seen in Fig. 1.

3 Result and Discussion

From the results of the Focus Group Discussion (FGD) and the results of the open questionnaire, there are eight criteria that are considered in the selection of suppliers at PT. Hope. The results of the identification of this criterion are carried out by PT. ASA, and from as many as twenty-two criteria from Dickson [13] and from Bilal and Yani (2010), eight criteria have been selected. The eight criteria, however, were later looked back at their original references, namely the Dickson (1996) and QFCDR criteria. The result is that the criteria under consideration are simplified to just seven criteria. This is due to the responsive criteria, by PT. ASA is included in the repair service criteria. Incorporation of responsive criteria into the repair service criteria, in accordance with the reference from Dickson (1996) and obtaining approval from the company PT. HOPE.

The compliance value for each criterion can be obtained from the results of the assessment of PT. Hope. This assessment process is through a closed questionnaire given to each PT. ASA as a respondent. At this stage, experts as respondents give a score as a result of their assessment of each criterion. This assessment has grades ranging from "very important" to "very unimportant". This assessment process is used as a basis for identifying the criteria that will be used as consideration in choosing a supplier.

The decision value of each supplier that acts as an alternative is the value given by each PT. ASA to each supplier. This value is based on the criteria used by considering the historical performance of each supplier. The assessment given by pt. ASA towards suppliers or suppliers, using a range or range of values with their assessment indicators.

The data quality tests carried out in this study include validity tests and reliability tests. Validity tests are carried out to find out whether each data obtained is considered valid or not. It is necessary to ensure the validity of the study, because if the data obtained are invalid, then the research results will also be invalid. The reliability test carried out is to find out about the consistency of the data obtained. Validity test and reliability test using SPSS software through correlation technique, namely product moment correlation. The first condition is if an instrument it is considered valid, only if its calculated r value is greater than r of the table. The second condition is if an instrument is considered valid, only if the significance of its correlation coefficient is less than 5%. Both conditions must be met all.

The data quality test is applied to the level of importance of each criterion and the value of the decision given to each alternative (Table 1). From the results of the validity test for the level of importance of the criteria in Table 1, it can be seen that the correlation

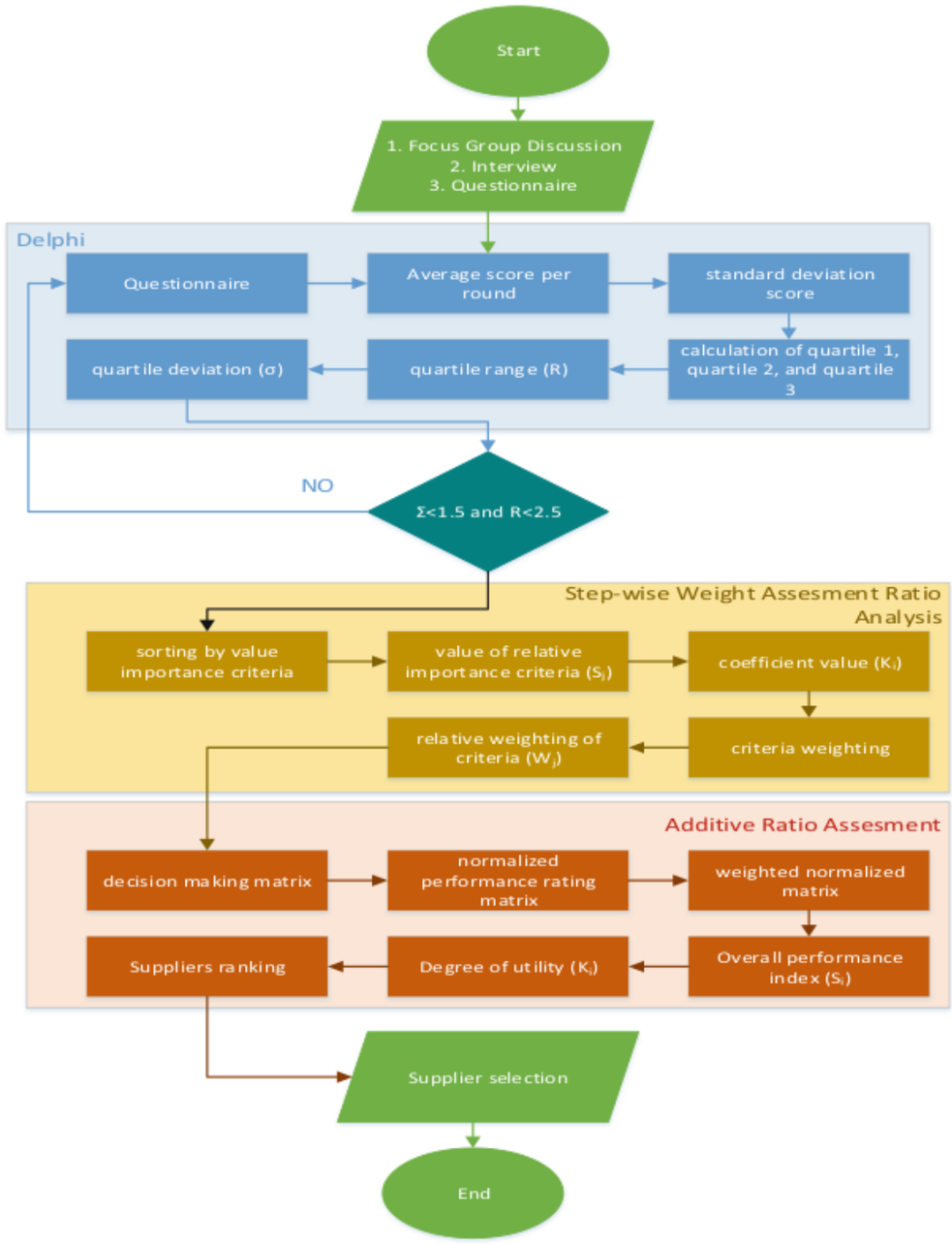

Fig. 1. Architecture of the proposed method.

values of all questions give valid results. This can be seen from the r value of the table as it is in the table r of the distribution with df = N-2 which is 5, so that the r of the table is worth 0.7545. As for the calculated r value from the validity test results using SPSS, it produces a calculated r value greater than 0.7545 with a coefficient significance value of less than 0.05. So it can be concluded that all the results of the questionnaire are valid.

Table 1. Validity test results for the level of importance value of the criteria.

Correlations					
		X01	X02	X03	Total
X01	Pearson Correlation	1	0.510	0.370	0.785*
	Sig. (2-tailed)		0.243	0.414	0.036
	N	7	7	7	7
X02	Pearson Correlation	0.510	1	0.495	0.779*
	Sig. (2-tailed)	0.243		0.259	0.039
	N	7	7	7	7
X03	Pearson Correlation	0.370	0.495	1	0.821*
	Sig. (2-tailed)	0.414	0.259		0.024
	N	7	7	7	7
Total	Pearson Correlation	0.785*	0.779*	0.821*	1
	Sig. (2-tailed)	0.036	0.039	0.024	
	N	7	7	7	7

*Correlation is significant at the 0.05 level (2-tailed).

Table 2. Reliability test results for criteria importance value levels.

Reliability Statistics	
Cronbach's Alpha	N of Items
.682	3

In reliability testing, the process is to use the coefficient analysis of *Cronbach's Alpha*. The test results of this process can be said to be reliable if the value of the alpha coefficient is greater than or equal to 0.6 as the critical value. As a result of the reliability test for the level of importance of the criteria can be seen in Table 2. The result of this test was by using SPSS software and obtained the value of *Cronbach's Alpha* for the results of the questionnaire more than a critical value of 0.6, so that the research questionnaire was declared reliable. The validity test results from the questionnaire data for supplier decision values can be seen in Table 3.

From Table 3, it can be concluded that all correlations of questions give valid results. This is because when viewed from the r value of the table r the distribution with df = N-2 produces the value 6, so the r of the table is 0.7067. Meanwhile, the calculated r value of the test results using SPSS is greater than 0.7067 for all criteria with constant price criteria. As for the significance value, it was obtained less than 0.05. So it can be concluded that all assessment results are valid. In addition, the follow-up conclusion is that the constant price criterion is due to the fact that respondents give the same value to each supplier. The results of the reliability test for the value level of the supplier's

Table 3. Validity test results for *supplier* decision value levels.

Correlations									
		X01	X02	X03	X04	X05	X06	X07	Total
X01	Pearson Correlation	1	0.846**	0.613	0.669	.[b]	0.377	0.574	0.839**
	Sig. (2-tailed)		0.008	0.106	0.070	.	0.357	0.137	0.009
	N	8	8	8	8	8	8	8	8
X02	Pearson Correlation	0.846**	1	0.316	0.863**	.[b]	0.306	0.713*	0.810*
	Sig. (2-tailed)	0.008		0.445	0.006	.	0.462	0.047	0.015
	N	8	8	8	8	8	8	8	8
X03	Pearson Correlation	0.613	0.316	1	0.273	.[b]	0.690	0.506	0.740*
	Sig. (2-tailed)	0.106	0.445		0.513	.	0.058	0.201	0.036
	N	8	8	8	8	8	8	8	8
X04	Pearson Correlation	0.669	0.863**	0.273	1	.[b]	0.490	0.716*	0.786*
	Sig. (2-tailed)	0.070	0.006	0.513		.	0.218	0.046	0.021
	N	8	8	8	8	8	8	8	8
X05	Pearson Correlation	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]
	Sig. (2-tailed)	.	.	.	.		.	.	.
	N	8	8	8	8	8	8	8	8
X06	Pearson Correlation	0.377	0.306	0.690	0.490	.[b]	1	0.644	0.742*
	Sig. (2-tailed)	0.357	0.462	0.058	0.218	.		0.085	0.035
	N	8	8	8	8	8	8	8	8
X07	Pearson Correlation	0.574	0.713*	0.506	0.716*	.[b]	0.644	1	0.880**
	Sig. (2-tailed)	0.137	0.047	0.201	0.046	.	0.085		0.004
	N	8	8	8	8	8	8	8	8

(*continued*)

Table 3. (*continued*)

Correlations									
		X01	X02	X03	X04	X05	X06	X07	Total
Total	Pearson Correlation	0.839**	0.810*	0.740*	0.786*	. b	0.742*	0.880**	1
	Sig. (2-tailed)	0.009	0.015	0.036	0.021	.	0.035	0.004	
	N	8	8	8	8	8	8	8	8

Table 4. Reliability test results for *supplier* decision value levels.

Reliability Statistics	
Cronbach's Alpha	N of Items
0,835	7

decision can be seen in Table 4. From the test results using SPSS software, the value of *Cronbach's Alpha* was obtained for the level of the supplier's decision value was more than the critical value (of 0.6), so it was concluded that the research questionnaire was declared reliable.

The determination of the criteria used in the selection of suppliers is carried out using the Delphi method. The tool used in the data retrieval is a questionnaire. The result is the criterion importance value level data as shown in Table 4. The data is then calculated its average value using the geometric mean equation. This average value is to find out whether or not there is an average of the criteria for the group of respondents that are under below or not. If there is a value whose position is below the number three, then the criterion will be omitted. The value of these three is determined based on the middle value of the grading scale used. The results of data processing to find the average value for each criterion can be seen in Table 5.

At this stage, it is to ensure that the results of the previous data processing have been reached a joint consensus, so that there is no need to distribute the next stage of the questionnaire. Although this subsequent questionnaire is still in the realm of assessing the criteria to be used. Meanwhile, the termination point of the Delphi process is when two requirements are met. The two conditions are a standard deviation of less than 1.5 and a quartile range of less than 2.5.

The results of processing statistical data for selected criteria using the Delphi Method can be seen in Table 6. Based on this table, it can be seen that the standard deviation value of each criterion is at a value of less than 1.5 with its quartile range value of 1.085 and less than 2.5. By looking at these results, it can be concluded that the statistical processing for the questionnaire results is in accordance with the common consensus. Thus, it is no longer necessary to carry out the dissemination of the next stage of the questionnaire for the determination of the criteria under consideration.

Table 5. Average score results for each criterion.

No.	Criterion	Criteria Value			Average Respondent Value
		R1	R2	R3	
1	Quality	5	5	5	5
2	Delivery	5	5	5	5
3	Price	5	4	3	3,915
4	Communication System	5	4	4	4,309
5	Complaints Procedure	3	4	3	3,302
6	Repair Service	4	5	4	4,309
7	Flexibility	4	3	5	3,915

The determination of weights for each of the criteria is carried out using the SWARA method. Input in the stage of determining the weight of the criteria, namely the ranking of each criterion. This value is obtained from the average importance value of each criterion from previous data processing. Based on the calculation of the average importance value of each criterion, it was concluded that the quality and delivery criteria were ranked first with a large value i.e. five. Meanwhile, the criteria for communication systems and repair services were ranked second by having an average score of 4,309. As for the price and flexibility criteria, it is included in the third place with an average value of 3,915. The last criterion, namely the complaint procedure, has a value of 3,309 so that it is ranked fourth.

The calculation for relative importance begins with the second criterion. Determining the relative importance of each criterion is by comparing the S_j rank value or ranking in criterion j with the average value of the rank or overall ranking. From the results mentioned above, it can be obtained that the average rank as a whole is 2.28571. Thus, the relative importance value of the delivery criteria is 0.4375. The input to be used in the calculation of the coefficient (K_j) is the value of S_j. From the calculations mentioned above, it can be obtained that the coefficient of delivery criteria is 1.4375. The value of q_j is a weight value that is calculated repeatedly to be an input to the calculation of the actual weight owned by each criterion. From the results of these calculations, it can be obtained that the initial weight of the delivery criteria is 0.69565. Final weight (W_j) is a value that interprets the actual weight for each criterion. By using the results of the final bot bombing, it can be determined what the level of importance of each criterion is. The results of processing data weighting criteria using SWARA method can be seen in Table 7.

Prioritization of suppliers or suppliers using the ARAS method. The input required in determining the priority of the supplier is the decision-making value for each criterion. The value is in Table 7, similarly for the final weight value of each criterion obtained in the previous data processing. The calculation of the utility rate is the final step of the ARAS. At this stage, it will determine the rating of each supplier (Table 8).

Based on the results of data processing carried out as in Table 9, it can be seen that Lumajang suppliers or suppliers are ranked first. This supplier can be used as a superior

Table 6. Results of statistical data processing of selected criteria.

no	Criterion	Criteria Value			Average Value	Standard deviation	Q_1	Q_2	Q_3	Ir	Quartile Deviation
		R1	R2	R3							
1	Quality	5	5	5	5	0	3,9	4,3	5	1.1	0,5
2	Delivery	5	5	5	5	0					
3	Price	5	4	3	3,9	0,2					
4	Communication System	5	4	4	4,3	0,1					
5	Complaints Procedure	3	4	3	3,3	0,1					
6	Repair Service	4	5	4	4,3	0,1					
7	Flexibility	4	3	5	3,9	0,2					

Table 7. Results of data processing weights criteria.

no	**Criterion**	**Code**	**Average**	**Rank**	S_j	K_j	q_j	W_j
1	Quality	C1	5	1	-	1	1	0,42
2	Delivery	C2	5	1	0,43	1,43	0,69	0,30
3	Communication System	C3	4,30	2	0,87	1,87	0,37	0,15
4	Repair Service	C4	4,30	2	0,87	1,87	0,20	0,08
5	Price	C5	3,91	3	1,31	2,31	0,09	0,04
6	Flexibility	C6	3,91	3	1,31	2,31	0,04	0,02
7	Complaints procedure	C7	3.30	4	1,75	2,75	0,02	0,01
	Average			**2,29**	**Sum**		**2,40**	**1**

supplier or priority supplier with a utility level value (K_i) of 0.965. Meanwhile, Cianjur suppliers or suppliers are ranked second. Therefore, this supplier or supplier is the main reserve supplier with a utility rate of 0.963. Meanwhile, the last ranked supplier position is occupied by Jombang suppliers with a utility level of 0.749.

This sensitivity analysis is very necessary to do, in order to find out whether the model is very sensitive to changes in what parameters it does not. One of the parameter changes that occurred was a change in the assessment of criteria. Whether the ranking will change in the event of a change in the assessment criteria. If there is a change, the extent to which the change occurs. To answer this question, it is necessary to test the sensitivity test, where this test is carried out if one or one of the two assessments of the importance of the respondent's criteria is not obtained or is not used.

There are many varieties of events that make the emergence of several scenarios from sensitivity tests. This will affect the ranking of the criteria, where the variable becomes the input in the weighting of the criteria. Therefore, such conditions will affect

Table 8. Initial decision matrix values.

Supplier	**Criterion**						
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
S0	**90**	**90**	**85**	**80**	**80**	**90**	**95**
S1	90	85	80	70	80	80	95
S2	70	80	70	70	80	70	80
S3	85	90	80	80	80	80	90
S4	60	70	70	70	80	60	55
S5	80	85	60	75	80	70	65
S6	65	60	80	70	80	90	70
S7	90	80	85	70	80	70	60
S8	60	70	75	65	80	60	55
Types of criteria	Benefits	Benefits	Benefits	Benefits	Cost	Benefits	Benefits

Table 9. Supplier ratings.

Supplier	**Utility level (Ki)**	**Rank**
Lumajang	0,965	1
Cianjur	0,963	2
Sidoarjo	0,952	3
Cirebon	0,882	4
Kediri	0,832	5
Wonogiri	0,765	6
Rembang	0,753	7
Jombang	0,749	8

the amount of weight on each criterion. This sensitivity test is carried out so that it can be known how much influence the weight change affects the supplier's priority order rating. The full results of this sixth sensitivity test when a graph is made can be seen in Table 10.

Table 10. Summary of utility levels of all scenarios.

Supplier	**Preliminary data**	**Sensitivitas 1**	**Sensitivitas 2**	**Sensitivitas 3**	**Sensitivitas 4**	**Sensitivitas 5**	**Sensitivitas 6**
Lumajang	0,965	0,965	0,966	0,966	0,964	0,964	0,964
Cianjur	0,963	0,965	0,962	0,962	0,963	0,964	0,963
Sidoarjo	0,952	0,953	0,951	0,952	0,953	0,954	0,954
Cirebon	0,882	0,883	0,881	0,879	0,880	0,877	0,877
Kediri	0,832	0,831	0,834	0,834	0,831	0,830	0,831
Wonogiri	0,765	0,761	0,769	0,770	0,772	0,769	0,771
Rembang	0,753	0,750	0,757	0,759	0,754	0,752	0,756
Jombang	0,749	0,756	0,753	0,754	0,750	0,748	0,751

4 Conclusion

Supplier priority order ratings are recommended to companies so that the company has a reference and makes it easier for companies to determine several suppliers to be selected in advance to make raw material order transactions by considering the criteria for assessing the performance of previous suppliers. In a certain few months or periods the company chooses 2–3 suppliers to meet the raw materials, and never uses 8 suppliers in one particular period/time. Therefore, the ranking of supplier priority order is very useful for the company if one of the suppliers is suddenly not available to supply raw materials, the company will be able to select other suppliers quickly by referring to the existing supplier priority order, thus it does not hinder the entire production system.

Acknowledgments. I would like to thank LPPM UPN Veteran Yogyakarta for their funding supported.

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