

# Production Prioritization at PT. XYZ with Stock Needs Rule (SNR) Method and Analytical Hierarchy Process

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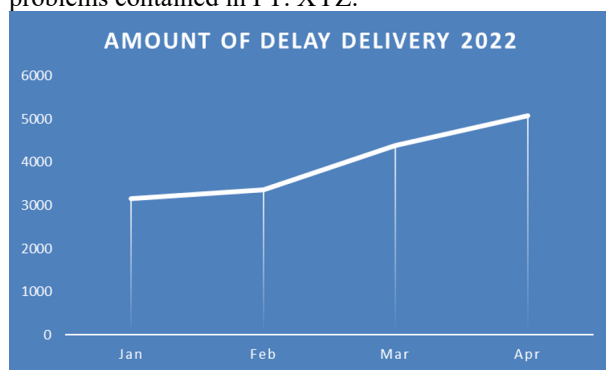
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**Abstract.** The intensity of delay delivery at PT. XYZ continues to increase. The cause of these delays is the changes in production schedules due to fluctuating daily demand and the fulfillment of customer requests based on customer priorities. This study aims to create a model for determining the prioritization of running production that minimizes delivery delays by considering objective factors such as shortage dates and balance stock, and subjective factors such as customer priority. The methods used for determining production priorities are the Stock Needs Rule (SNR) and Analytical Hierarchy Process (AHP). This model utilizes three criteria for determining the prioritization of running part numbers, that is: shortage dates that consider the daily stock quantity of finished goods, Work in Process (WIP), and previous day's demand; balance stock that considers the inventory stock and the demand that needs to be fulfilled during the lead time; and customer priority that takes into account the intensity of demand fluctuations, loyalty, and fixed product usage time. With this model, PT. XYZ can determine the priority part numbers that need to be produced first.

## 1 Introduction

Product availability will be a problem for the company if there is a lack of available stock to fulfil customer demand. One of the risks faced is the delay in delivery to customers. This is in accordance with one of the problems contained in PT. XYZ.



**Fig. 1.** Grafik Delay Delivery Jan - Apr 2022

Figure 1 shows that cases of delay delivery continued to increase during January to April 2022. This condition is quite a concern for PT. XYZ to overcome the case of delay delivery owned by the company. According to research of Kusriani[2], there are several factors that cause delay delivery, one of which is the FG transfer factor. This FG transfer factor is triggered by three other factors, which is planning, quality check, and material order. In addition, according to the results of an

interview with PT. XYZ, the fluctuation of demand given by customers is one of the triggers for delivery delays.

The company sets a strategy in overcoming delivery delays. One of the strategies used by companies is to do daily scheduling by considering objective and subjective factors so as to maximize their production schedule. This scheduling is done by determining the priority part number that must be produced on that day.

The objective factors used are the amount of daily stock and the amount of daily demand. In accordance with the Stock Needs Rule (SNR) method in Razafuad, Ridwan and Santosa [5] which considers the ratio of the amount of stock and the amount of demand during lead time. The smallest ratio between the amount of stock and the amount of demand during the lead time. This method is proven to reduce the number of 0-pick or stockout by 76.5% [9].

In addition to objective factors, there are subjective factors used by companies in determining production priorities. This subjective factor considers the company's assessment of their customers. The assessment used includes the intensity of fluctuations in demand, loyalty, and fixation of product use time. This is related to buyer dependence conveyed by Dixit, Srivastava and Chaudhuri [1] in their research. According to the study, buyer dependence plays an important role in contract agreements such as lead time, pricing, etc. this factor is also influenced by the number of suppliers and negotiating power.

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The AHP method is a measurement theory. The AHP method provides a fundamental scale of relative quantities indicated by dominant units representing dominance values in pairwise comparison forms Saaty and Katz [6]. The use of AHP in decision making relies on relative measurement theory which is based on comparisons between pairs used for standard tables of absolute numbers, where the elements are then used as priorities [7]. Therefore, this study uses the AHP method to combine objective and subjective assessments of companies to determine production running priorities.

## 2 Research Methodology

In this study, three method of data collection are needed, which is interview, questionnaire, and data that has been collected by the company.

### 2.1 Stock Needs Rule (SNR)

The SNR method is carried out by comparing data on the amount of company stock with the amount of demand during manufacturing lead time. The data used includes data on the number of requests for five days (manufacturing lead time). From this data, it can be known the level of emergency status of each product. The lower the ratio value, the higher the emergency level of the product

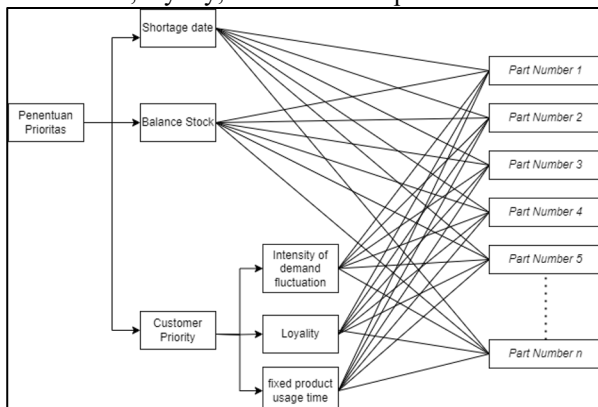
$$Status\ stock = \frac{S_h}{\sum_{k=1}^{N_h} Q_h(k)}$$

Information:

- $S_h$  : Number of products on the day to h
- $\sum_{k=1}^{N_h} Q_h(k)$  : Total number of product requests h during lead time

### 2.2 Analytical Hierarchy Process (AHP)

The purpose of AHP is to rank production priorities at PT. XYZ by considering objective and objective factors as a whole. This is done to minimize intervention in decisions by displaying objective data. The criteria used are shortage date, balance stock, and customer category. In the customer priority criterion, there are three derivative sub-criteria, which is: intensity of demand fluctuations, loyalty, and fixation of product use time



**Fig. 2.** Hierarchy Structure for production prioritization

In making decisions on priority running production at PT. XYZ uses several criteria, namely: shortage date (C1), balance stock (C2), and customer priority (C3). In the customer priority criteria, 3 derivative criteria are obtained, namely: intensity of demand fluctuations (SC3.1), loyalty (SC3.2), and fixation of product use time (SC3.3). The assessment of part numbers against these three criteria and sub-criteria is a determining factor for production priorities on the day the scheduling is carried out.

This comparison data is obtained by giving questionnaires to decision makers, namely loading production plan employees and customer service. The form given is in the form of a comparison of criteria measured using the Saaty scale. After the data is collected, the data processing stage is carried out to determine the priority of the importance of the criteria. Then the calculation of the maximum eigenvalue is carried out ( $\lambda_{maksimum}$ ) and a consistency test is carried out by calculating the CI (Consistency Index) and CR (Consistency Ratio) values. If the CR value  $< 0.1$ , the assessment criteria are declared consistent. If the CR value  $> 0.1$ , the assessment criteria must be corrected.

Criterion 1 is the shortage date (C1). In C1, the parameter of the number of days is used where the total stock cannot meet customer demand in the time span during the lead time calculated starting on that day. The rating scale used is 1-5. The more days that the product is stockouted, the higher the value of the part number against this criterion. Here is the formula for calculating the amount according to the company's calculations:

$$S_{h(i)} = Q_{FG(i)(h-1)} - O_{i(h-1)} + Q_{SC(i)(h-2)} + Q_{MFG2(i)(h-3)} + Q_{MFG1(i)(h-4)}$$

Information :

- $S_{h(i)}$  : Total stock of product i on day h  $h(i) = \{x \mid 0 \leq x \leq 5\}$
- $Q_{FG(i)(h-1)}$  : Product quantity i in FG warehouse on day h-1
- $O_{i(h-1)}$  : Quantity of product i orders sent to customers on the day h-1
- $Q_{SC(i)(h-2)}$  : Quantity of product i at warehouse subcont on day h-2
- $Q_{MFG2(i)(h-3)}$  : Quantity of product i at warehouse MFG 2 on day h-3
- $Q_{MFG1(i)(h-4)}$  : Quantity of product i at warehouse MFG 1 on day h-4

From the calculation of the value of  $S_{h(i)}$  will be obtained the amount of stock owned by the company for the next five days in accordance with the company's manufacturing lead time. With this, the company knows the day or time when the company is experiencing a shortage of stock. This is aimed at the number of stocks that are negative on a certain day. The number of days on which the stock is negative indicates the value of the Shortage date (C1).

Criterion 2 used is balance stock. Balance stock is a unit of product shortage units that must be produced by companies to meet their customer demand. The company uses the stock status parameter because when the demand is smaller than the amount of stock, the stock balance is considered non-existent. With stock status, product stock status is known to be in safe

condition or needs to be produced to meet customer demand. Stock status shows the number of comparisons of the amount of stock owned by both FG and WIP companies with total demand during lead time. Part number assessment in accordance with the results of stock status calculations obtained through the SNR method.

Criterion 3 is the customer category (C3). In C3, the value of the calculation obtained is used in the calculation of the cumulative value of the sub-criteria. In the customer priority criteria, there are three sub-criteria, namely: intensity of demand fluctuations (SC3.1), loyalty (SC3.2), and fixation of product use time (SC3.3). sub-criterion of demand fluctuation intensity (SC3.1), the assessment is based on the amount of daily demand fluctuation. The more often the intensity of demand fluctuations, the higher the value obtained. This assessment uses a Likert scale with a scale of 1-4. The loyalty sub-criteria (SC2) is based on the company's level of sales (number of products and frequency of purchases) to the customer. The higher the sales value, the higher the value given to the customer. The sub-criteria for fixation of product use time (SC3.3) is based on the determination of kanban or product usage schedule for the customer. The fixation of product usage time is related to the potential stop line that will be

experienced by customers if there is a delay in product delivery.

Data normalization is a preprocessing technique that involves either scaling or altering the data to ensure that each feature contributes equally [8]. In this study, two ways of data normalization were carried out, namely MinMax normalization and interpolation. Normalization with MinMax is carried out for criteria (C1, SC3.1, SC3.2, SC3.3) and for balance stock criteria (C2) interpolarization normalization is used with the following formula:

$$y=y_1+(X-X_1)\frac{(Y_2-Y_1)}{(X_2-X_1)}$$

The last stage that needs to be done to determine production priorities is to calculate the cumulative final value of the product. The cumulative value is obtained by summing the results of the normalization multiplication of the assessment score with the weight of each criterion and subcriteria used.

### 3 Result

#### 3.1 Stock Needs Rule (SNR)

**Table 1.** Stock Needs Rule

Part Number	Stock FG (unit)	demand through leadtime	Stock/Demand (unit/ 5 day)	Total Stock (Stok WIP + Stok FG)	Status stok	min stock	Status Stock
Part-1730	0	350	0	0	0.00	350	danger
Part-2031	0	500	0	0	0.00	500	danger
Part-1319	0	2000	0	66	0.03	2000	danger
Part-1562	0	500	0	20	0.04	500	danger
Part-1018	0	1000	0	64	0.06	1000	danger
Part-2027	0	2000	0	141	0.07	2000	danger
Part-1478	0	1600	0	131	0.08	1600	danger
Part-1084	0	788	0	68	0.09	788	danger
Part-1125	0	800	0	73	0.09	800	danger
Part-1085	0	1000	0	110	0.11	1000	danger
Part-1323	0	1000	0	147	0.15	1000	danger
Part-1523	0	876	0	256	0.29	876	danger
Part-1231	0	1000	0	317	0.32	1000	danger
Part-1599	0	200	0	65	0.33	200	danger
Part-1473	0	1000	0	396	0.40	1000	danger
Part-1559	0	862	0	348	0.40	862	danger

Table 1 shows the table of the result of calculating the ratio between the amount of stock and the number of requests during leadtime (5 days). From the table, it can be seen that some product level inventory is not enough

to meet demand for 5 days. This is indicated by the ratio of FG stock to the number of requests below 0 (zero). Then, to determine the overall product level inventory status, a comparison was made between the total stock

amount of both FG and WIP and then compared with the total demand during the lead time. If the stock inventory level is less than the number of requests for 5 days, the product inventory status is said to be in a "Danger" state. If the inventory level is equal to the number of requests for 5 days, the product inventory status is said to be in a "Warning" state. And if the stock inventory level is more than the number of requests for 5 days, the product inventory status is said to be in a "Safe" state.

### 3.2 Analytical Hierarchy Process (AHP)

As explained earlier, the use of the AHP method aims to rank part numbers to determine the priority of running production on that day. The results of the questionnaire given to customer service and team production plan leaders obtained the following sequence results:

**Table 2.** Sequence Priority Number Of Each Decision Maker

Preference	Decision Maker				
	2	1	1	1	1
1st	C1	C1	SC3.2	SC3.2	SC3.3
2nd	C3	C2	SC3.3	SC3.1	SC3.2
3rd	C2	C3	SC3.1	SC3.3	SC3.1

Based on the assessment of the criteria and subcriteria of each expert, the step taken is to calculate the weighting on each criterion and sub-criteria that have been determined. The weighting is carried out on the basis of criterion assessment using the Saaty scale [4]. The assessment data from each expert was calculated with geometric mean and normalized matrix calculations to obtain eigenvector values for each criterion and consistency tests were carried out so that CI and CR values were obtained with the following formula:

$$\lambda_{maks} = \sum C_{ji} \times W_i \quad (2)$$

$$CI = \frac{\lambda_{maks} - n}{n - 1} \quad (3)$$

$$CR = \frac{CI}{RI}$$

From this calculation, the weighting and consistency Ratio are obtained as follows. From this calculation, the weighting value and consistency ratio are obtained as follows:

**Table 3.** Calculation Of Criterion Weighting Value

	C1	C2	C3	total	Eigen Vector
C1	1.00	6.80	4.22	12.02	0.72
C2	0.15	1.00	0.44	1.59	0.09
C3	0.24	2.27	1.00	3.51	0.19
Total	1.38	10.07	5.66	17.11	1.00
Lambda max	3.01				
CI	0.00				
CR	0.01				

**Table 4.** Calculation Of Sub Criterion Weighting Value

	SC3.1	SC3.2	SC3.3	total	Eigen Vector
SC3.1	3.00	0.54	0.65	4.20	0.09
SC3.2	17.71	3.00	3.71	24.42	0.50
SC3.3	14.75	2.60	3.00	20.35	0.42
Total	35.46	6.15	7.36	48.97	1.00
Lambda max	3.05				
CI	0.03				
CR	0.05				

The calculation shows that the CR value of each assessment criterion and sub-criterion is less than 10%. Therefore, the assessment of the three experts can be declared consistent.

To determine production priorities, it is necessary to create an AHP model. Thus, it is necessary to calculate the global priority value of each sub-criterion against the customer priority criterion.

$$GP = W_{i_{customer\ priority}} \times W_{i_{Sub\ criterion}} \quad (4)$$

The weighting results obtained by each sub-criterion, namely the intensity of demand fluctuations of 0.02, loyalty of 0.09, and fixation of product use of 0.08. So that the model can be formulated as follows:

$$\text{Production Priority} = 0.72C1 + 0.09C2 + 0.02SC3.1 + 0.09SC3.2 + 0.08SC3.3$$

The calculation of the value of each part number is used as a reference for production priorities to be carried out on that day. The part number with the highest value indicates that the part number must take precedence to be produced today.

**Table 5.** Score Assessment Of Each Part Number

Part Number	Customer	Score Assessment				
		Shortage Date (C1)	Balance Stock (C2)	Intensity of demand fluctuation (SC3.1)	Loyalty (SC3.2)	Fixed product usage (SC3.3)
Part-1003	PT. M	0	2.326	2	1	3
Part-1004	PT. M	0	4.347	2	1	3
Part-1010	PT. AE	0	1.461	3	3	4

Part-1017	PT. AD	0	2.530	2	1	3
Part-1018	PT. AD	4	0.064	2	1	3
Part-1023	PT. U	0	8.464	1	1	2
Part-1030	PT. U	0	2.115	1	1	2
Part-1031	PT. AC	0	2.343	3	4	4
Part-1032	PT. AM	0	1.108	2	4	3
Part-1037	PT. M	0	5.524	2	1	3
Part-1045	PT. M	0	2.083	2	1	3
Part-1051	PT. M	0	3.057	2	1	3
Part-1054	PT. M	0	3.213	2	1	3
Part-1055	PT. M	0	4.028	2	1	3
Part-1063	PT. AI	0	2.744	4	2	4
Part-1064	PT. M	0	3.235	2	1	3

The assessment of part numbers against each criterion and sub-criteria has a different scale so it is necessary to normalize each assessment. Normalization of assessments is carried out to equalize the assessment

range so that a more accurate comparison value is obtained.

**Table. 6.** Normalization Of Score Assessment

Part Number	Normalization Score Assessment				
	<i>Shortage Date (C1)</i>	<i>Balance Stock (C2)</i>	<i>Intensity of demand fluctuation (SC3.1)</i>	<i>Loyalty (SC3.2)</i>	<i>Fixed product usage (SC3.3)</i>
Part-1003	0	0.4906	0.3333	0.0000	0.6667
Part-1004	0	0.4762	0.3333	0.0000	0.6667
Part-1010	0	0.4967	0.6667	0.6667	1.0000
Part-1017	0	0.4891	0.3333	0.0000	0.6667
Part-1018	0.8	0.9680	0.3333	0.0000	0.6667
Part-1023	0	0.4470	0.0000	0.0000	0.3333
Part-1030	0	0.4921	0.0000	0.0000	0.3333
Part-1031	0	0.4905	0.6667	1.0000	1.0000
Part-1032	0	0.4992	0.3333	1.0000	0.6667
Part-1037	0	0.4679	0.3333	0.0000	0.6667
Part-1045	0	0.4923	0.3333	0.0000	0.6667
Part-1051	0	0.4854	0.3333	0.0000	0.6667
Part-1054	0	0.4843	0.3333	0.0000	0.6667
Part-1055	0	0.4785	0.3333	0.0000	0.6667
Part-1063	0	0.4876	1.0000	0.3333	1.0000
Part-1064	0	0.4841	0.3333	0.0000	0.6667

The assessment calculation of each part number is carried out after the normalization value of the assessment score is obtained. Calculation with the AHP

model uses the assessment score value that has been obtained previously. The results of the assessment obtained the following rank:

**Table. 7.** Rank Of Each Part Number

Part Number	Result					
	Shortage Date (C1)	Balance Stock (C2)	Intensity of demand fluctuation (SC3.1)	Loyalty (SC3.2)	Fixed product usage (SC3.3)	Shortage Date (C1)
Part-1003	0.0000	0.046	0.005	0.000	0.053	0.104
Part-1004	0.0000	0.044	0.005	0.000	0.053	0.102
Part-1010	0.0000	0.046	0.011	0.063	0.079	0.199
Part-1017	0.0000	0.046	0.005	0.000	0.053	0.104
Part-1018	0.5735	0.090	0.005	0.000	0.053	0.722
Part-1023	0.0000	0.042	0.000	0.000	0.026	0.068
Part-1030	0.0000	0.046	0.000	0.000	0.026	0.072
Part-1031	0.0000	0.046	0.011	0.095	0.079	0.230
Part-1032	0.0000	0.047	0.005	0.095	0.053	0.199
Part-1037	0.0000	0.044	0.005	0.000	0.053	0.102
Part-1045	0.0000	0.046	0.005	0.000	0.053	0.104
Part-1051	0.0000	0.045	0.005	0.000	0.053	0.103

Thus, the priority value and ranking of each part number are obtained. PT. XYZ can determine which part number will need to be produced first for the day.

#### 4 Discussion

In table 1, the result of the ratio of stock to the amount of demand during lead time is obtained. Results show that more than 35 products have a ratio of <1. This shows that more than 35 products are in danger conditions where the company's stock is declared unable to meet customer demand. However, the company has limitations in the implementation of running production. In one production run, the company can only use 35 CNC machines to carry out the production process. For this reason, calculations are carried out using the AHP method to calculate the priority value of each alternative part number so that it can be determined which part number will be carried out in the production process first.

In the AHP method, there are three criteria with each weight value, namely shortage date (C1) of 0.72, Balance stock (C2) of 0.09, and customer priority (C3) of 0.19. Criterion 3 (C3) has 3 sub-criteria with each weight, namely the intensity of demand fluctuations (SC3.1) of 0.09, loyalty (SC3.2) of 0.50, and fixation of product use time (SC3.3) of 0.42.

The results obtained in the AHP method show that the highest assessment weight is found in the shortage date criteria (C1) and loyalty sub-criteria (SC3.2). This shows that the lower the ability of the stock that the

company has to meet customer demand for certain products, the higher the priority value of the product. And the product will increasingly become a priority if the product is a product ordered by customers who have high loyalty to the company.

Table 5 shows the scoring results of each part number. In the table, you can see the column of part number and customers who ordered the part number. Customers of each part number will provide a part number value against the customer priority criteria (C3) and each sub-criterion. Thus, each alternative part number gets an assessment of each criterion and sub criterion.

The scoring process carried out on each part number has a different scale on each criterion. This shows the need for a data normalization process so that the results obtained are more accurate. In the balance stock (C2) criterion, normalization is carried out by interpolation so that products with stock status of  $0 \leq x \leq 1$  will get a normalization value of  $0.5 \leq x \leq 1$ . Meanwhile, products with stock status  $>1$  will get a normalized value of  $0 \leq x \leq 0.5$ . This is because the balance stock (C2) criterion shows that products with stock status  $<1$  are products with the amount of stock less than the amount of demand during the manufacturing lead time.

The calculation results using the AHP model can be seen in table 7. The part number with the highest cumulative value is stated as the product that must be prioritized for production on that day.

## 5 Conclusion

This study discusses delivery delays caused by fluctuations in daily demand by customers and demand fulfillment based on consumer priorities. The method that can be used is the AHP method. With this method, the Company can determine the ranking of each part number so that it can determine production priorities more objectively. The criterion that most influences production priorities is the shortage date (C1) criterion with an assessment weight of 0.72 criteria. While the sub-criterion of customer priority criteria (C3) that most affects production priority is the loyalty sub-criterion (SC3.2) with an assessment weight of 0.50.

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