# Raw Material Wood Inventoru Monitoring With Rule Based Forward Chaining

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***Abstract*** **-- In rivalry to meet market demand , the company should have a good supply such as avoidance of deficiency or excess inventory of raw materials , because they will cause tiingi costs for the company . Safety stock is an additional supply must always exist in the company to anticipate fluctuations in demand , thus setting the optimal safety stock levels can reduce the average cost of inventory and can meet customer service levels . The process involves the safety stock lead time of any goods from suppliers and the average consumption of raw materials by the production department . Forward chaining rule -based will help monitor the position of the existing stock in warehouse . Rule based forward chaining would involve three parameters such as position in warehouse stock , safety stock and timber booking which will result in stock in a safe or unsafe and wood raw material stock in the free position , so that the management company can bring the decision to the procurement of materials raw return or not . Safety Stock in a level sufficient to launch an operation in accordance with the business plan of a company that has been established .**

***Keywords*** **: Inventory; Forward chaining; Safety stock.** 1.

### Introduction

Competitive enterprises in order to meet the market demand should be able to look good inventory, so there is no shortage and excess inventory of raw materials because they will lead to high costs for the company. The results of each audit firm always fail in dealing with the raw material inventory. The raw material is a major component in the manufacture of a product, both finished products and semi-finished products (Adegoke et al., 2012). Wood is the main raw material for finished goods type doors, wood from unpredictable natural style and quality as the dryness of each timber.

Inventory inaccuracy is due to two main aspects: the physical aspects caused by depreciation, obsolescence and supplier fraud. The second aspect that caused loss of information such as barcode system, only the rare supporting audit due to the constraints of cost and time. Physical examination process takes longer time than the booking process. Inaccurate inventory information will lead to decisions that fail to result in an additional cost (Dai and Tseng, 2012). Purchase of inventory items that are not in accordance with the requirements will result in a much needed warehouse, long storage will cause a defect on the item and require a lot of warehouse staff to keep the warehouse. This required the development of an effective inventory model with minimum inventory cost (Kulkarni and Rajhans, 2013).

Model-based or rule-based rules as a basis for the development of expert systems can handle inventory in a construction company, as a matter of procedure for the issuance of a steel pipe is very different from the general inventory problems (Venkatraman and Venkatraman, 2000). Expert system is also able to identify the malfunction or failure in the field of biology, electronics, and industrial or other systems by using the data collected (symptoms) and "forward-chaining" as a control strategy to develop damage will occur and determine the cause (Vranes et man, 1996). Penggambungan modeling point-of-view and forward chaining able to significantly give satisfaction to the parents who have children with autism in teaching their children to be independent (Shrestha et al., 2012).

Setting the optimal safety stock levels can reduce the average inventory costs and also help to meet customer service level (Tratar, 2009). Safety stock can also be used for production scheduling problems with several items with random demands in a single machine facility (Brander and Forsberg, 2005). Safety stock is combined with the supply chain to minimize the processing costs, transportation costs and procurement costs (Funaki, 2010). Method availability and method of service levels is a common method used to determine the level of safety stock (Thomopoulos, 2006).

**2. Theory**

Safety stock or buffer stock is also called extra supplies that should always exist within the company to anticipate fluctuations in demand (Dai and Tseng, 2012). Shortage of raw materials is usually caused by two factors: the use of materials than usual and there is delay in delivery of raw materials. Number of Safety Stock in the supply chain is very important for manufacturing companies to meet unpredictable demand and to provide a good level of service to customers. Safety Stock in a level sufficient to launch an operation in accordance with the business plan of a company that has been established.

Lead time is the time interval between order submission and receipt of the order preparation of suppliers. For products or components manufactured internally, the lead time can be defined as the total time required to obtain the necessary raw materials and components or buy, carry out the necessary processing, fabrication, and assembly steps, packing and shipping the goods to other divisions within the company or to customers (Haming and Nurnajamuddin, 2012).

Policy to determine the level of service level expressed as a percentage of each company. Service factor used as a multiplier to calculate the standard deviation for a certain amount to meet certain service levels. To change the percentage of service level to the service factor NORMSINV can use Excel functions. Percentage of service level and service level factors are shown in Table 1 (Celik, 2013):

Table 1
*Table Service Factoc*

| No | Service Level | Service Factor | No | Service Level | Service Factor |
|---|---|---|---|---|---|
| 1 | 50.00 % | 0 | 17 | 90.00 % | 1.28 |
| 2 | 55.00 % | 0.13 | 18 | 91.00 % | 1.34 |
| 3 | 60.00 % | 0.25 | 19 | 92.00 % | 1.41 |
| 4 | 65.00 % | 0.39 | 20 | 93.00 % | 1.48 |
| 5 | 70.00 % | 0.52 | 21 | 94.00 % | 1.55 |
| 6 | 75.00 % | 0.67 | 22 | 95.00 % | 1.64 |
| 7 | 80.00 % | 0.84 | 23 | 96.00 % | 1.75 |
| 8 | 81.00 % | 0.88 | 24 | 97.00 % | 1.88 |
| 9 | 82.00 % | 0.92 | 25 | 98.00 % | 2.05 |
| 10 | 83.00 % | 0.95 | 26 | 99.00 % | 2.33 |
| 11 | 84.00 % | 0.99 | 27 | 99.50 % | 2.58 |
| 12 | 85.00 % | 1.04 | 28 | 99.60 % | 2.65 |
| 13 | 86.00 % | 1.08 | 29 | 99.70 % | 2.75 |
| 14 | 87.00 % | 1.13 | 30 | 99.80 % | 2.88 |
| 15 | 88.00 % | 1.17 | 31 | 99.90 % | 3.90 |
| 16 | 89.00 % | 1.23 | 32 | 99.99 % | 3.72 |

### *2.2.* Reference Library


Adegoke, G.K., Aimufua, G.I.O., Jegede, A.J., 2012, Computer modelling and simulation for inventory control. *Research Journal of Applied Sciences, Engineering and Technology 4(13): 1828-1832*.

Brander, P., and Forsberg, R., 2005, Determination of safety stocks for cyclic schedules with stochastic demands, Int. *J. Production Economics 104. 271–295.*

Çelik ozge., 2013, Optimization of safety stock level in a manufacturing company, *school of industrial engineering and telecommunication university of cantabria*.

Dai, H., and Tseng, M.M., 2012, The impacts of RFID implementation on reducing inventory inaccuracy in a multi-stage supply chain, *Int. J. Production Economics 139. 634–641.*

Funaki, K., 2010, Strategic safety stock placement in supply chain design with due-date based demand, *Int. J. Production Economics 135. 4–13*.

Kulkarni Samak S.M., and Rajhans.N.R., 2012, Determination of Optimum Inventory Model for Minimizing Total Inventory Cost, *Procedia Engineering 51 803 – 809.*

Shrestha, A., Anderson, A., Moore, D.W., 2012, Using point-of-view video modeling and forward chaining to teach a functional self-help-skill, *J Behav Educ 22:157–167 DOI 10.1007/s10864-012-9165-x*.

Thomopoulos, N.T., 2006, Safety Stock comparison with Availability and Service level, The International *Applied Business Research (IABR) Conference in Cancun, Mexico.*

Tratar, L.F., 2009, Minimising inventory costs by properly choosing the level of safety stock, *Economic and business review vol. 11 no. 2. 109–117* .

Venkatraman, R., and Venkatraman, S., 2000, Rule-based system application for a technical problem in inventory issue, *Artificial Intelligence in Engineering 14. 143–152.*

*2.3.* Abbreviations and Acronyms

SS (*safety stock*), *LT (Lead time).*

*D. E*equation formula

Formula *standar deviasi*:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(d_i - \bar{d})^2}{N - 1}} \qquad (1)$$

Formula *Safety stock* :

$$SS = \alpha\sqrt{LT.\sigma^2} \qquad (2)$$

N = the amount of data
$\sigma$ = standar deviasi
$d_i$ = used for i
$\bar{d}$ = average usage
SS = safety stock
$\alpha$ = level service level
*LT = lead time.*

## 3. Methodology

Type of wood used is meranti with a length of 2100 mm, width 150 mm and thickness 26 mm are being sampled for counting. To get the value of the average lead time on this type of timber to purchase and retrieve data entry or arrival of goods, then we will get the value of the average lead time. The average value of raw material this meranti, obtained from the whole of usage within a certain time, using the standard deviation formula, wherein each raw material usage in a day will be reduced by the value of the average usage.

Safety stock level will be obtained from the multiplication rate service level multiplied by the square root multiplied by the lead time standard deviation squared. Rate the level of service that is used in this study was 95% which, if there is demand for 100 items of type door it will assume an error of 5 items. This is due to the wood raw material is the result of nature which can not dipridiksi ranging from dryness level until the power level of tone.

Monitoring of raw materials inventory after getting the level of safety stock. In monitoring inventory stock which will result in a free state, warning stock safe or not safe. use of rule-based forward chaining would involve additional parameters: current stock and booking component wood species. Rule based forward chaining is used is as follows:

**R1** : IF (Current Stock > Safety Stock ) and Booking Then
Stock Free = Current Stock – Booking
**R2** : IF (Current Stock > Safety Stock ) and (Not Booking) Then
Stock Free = Current Stock
**R3** : IF (Current Stock <= Safety Stock ) and Booking Then
Stock Free = Current Stock – Booking
**R4** : IF (Current Stock <= Safety Stock ) and (Not Booking) Then
Stock Free = Current Stock
**R5** : IF (Stock Free > Safety Stock ) Then
Pesan stock dalam keadaan aman
**R6** : IF (Stock Free <= Safety Stock ) Then
Pesan stock dalam keadaan tidak aman

## 4. Results and Discussion

In this study, performed safety stock per quarter, and taken samples of the first quarter or the same as the month of January 2013 until March 2013. This is done to determine the highest demand in a year divided per quarter.

Here's the data from January 2013 to march 2013, which is used for calculating safety stock.

Table 2. Data purchases in January to march 2013

| no_trx_p | tgl_trx_p | kd_kayu | jml_kayu |
|---|---|---|---|
| PL000000001 | 1/3/2013 | BK00003 | 600 |
| PL000000002 | 1/7/2013 | BK00002 | 1654 |
| PL000000003 | 1/7/2013 | BK00002 | 1682 |
| PL000000004 | 1/8/2013 | BK00001 | 1165 |
| PL000000005 | 1/8/2013 | BK00001 | 446 |
| PL000000006 | 1/9/2013 | BK00001 | 1877 |
| PL000000007 | 1/10/2013 | BK00004 | 846 |
| PL000000008 | 1/20/2013 | BK00003 | 1421 |
| PL000000009 | 2/3/2013 | BK00002 | 1592 |
| PL000000010 | 2/7/2013 | BK00004 | 752 |
| PL000000011 | 2/10/2013 | BK00003 | 139 |
| PL000000012 | 2/12/2013 | BK00001 | 779 |
| PL000000013 | 2/12/2013 | BK00001 | 1318 |
| PL000000014 | 2/12/2013 | BK00003 | 80 |
| PL000000015 | 3/3/2013 | BK00001 | 523 |
| PL000000016 | 3/10/2013 | BK00002 | 826 |
| PL000000017 | 3/15/2013 | BK00005 | 1316 |
| PL000000018 | 3/21/2013 | BK00004 | 752 |
| PL000000019 | 4/4/2013 | BK00004 | 752 |
| PL000000020 | 4/17/2013 | BK00002 | 1011 |

Table 3. Data timber arrival in January until March of 2013.

| no_trx_m | no_trx_p | kd_kayu | jml_kayu |
|---|---|---|---|
| GM000000001 | PL000000001 | BK00003 | 600 |
| GM000000002 | PL000000002 | BK00002 | 1654 |
| GM000000003 | PL000000003 | BK00002 | 1682 |
| GM000000004 | PL000000004 | BK00001 | 1165 |
| GM000000005 | PL000000005 | BK00001 | 446 |
| GM000000006 | PL000000006 | BK00001 | 1887 |
| GM000000007 | PL000000007 | BK00004 | 846 |
| GM000000008 | PL000000008 | BK00003 | 1421 |
| GM000000009 | PL000000009 | BK00002 | 1592 |
| GM000000010 | PL000000010 | BK00004 | 752 |
| GM000000011 | PL000000011 | BK00003 | 139 |
| GM000000012 | PL000000012 | BK00001 | 779 |

| | | | |
|---|---|---|---|
| GM000000013 | PL000000013 | BK00001 | 1318 |
| GM000000014 | PL000000014 | BK00003 | 80 |
| GM000000015 | PL000000015 | BK00001 | 523 |
| GM000000016 | PL000000016 | BK00002 | 826 |
| GM000000017 | PL000000017 | BK00005 | 1316 |
| GM000000018 | PL000000018 | BK00004 | 752 |
| GM000000019 | PL000000019 | BK00004 | 752 |
| GM000000020 | PL000000020 | BK00002 | 1011 |

Table 3. Wood raw material consumption data in January until March of 2013.

| no_trx_k | kd_kayu | jml_kayu |
|---|---|---|
| GK000000001 | BK00001 | 106 |
| GK000000002 | BK00001 | 112 |
| GK000000003 | BK00001 | 106 |
| GK000000004 | BK00001 | 106 |
| GK000000005 | BK00001 | 108 |
| GK000000006 | BK00001 | 108 |
| GK000000007 | BK00001 | 112 |
| GK000000008 | BK00001 | 112 |

Based on the data, leadtime generated from wood type code BK00001 is 6 days and safety stock level of 4, meaning that it can backup safety stock 4 or 6 days in order to handle the production continues to run without having to stop to wait for the raw materials. And leadtime is needed dibutukan within 6 days of purchase, from the initial purchase of raw materials in the warehouse until ready to use.

Position last stock wood species BK00001 warehouse is 42 pcs and booking type the code by 38 pcs. By using a rule-based forward chaining already established the rule R1 is triggered and generate free stock by 5 pcs. With free stock gained by 5 pcs will trigger Rule R6 which will result in an unsafe stock. The management may take the decision to procure back as stock positions in a state of insecurity.

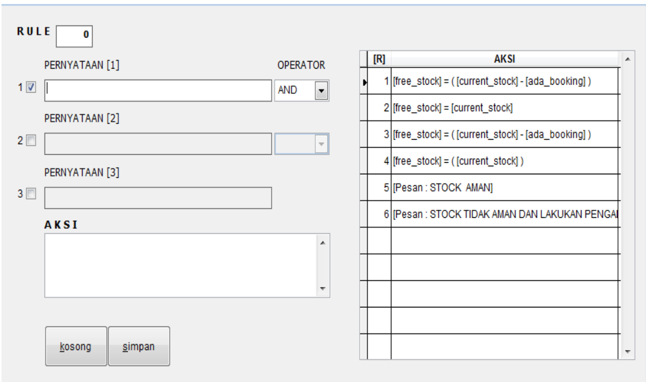


Figure 1. Rule-making based

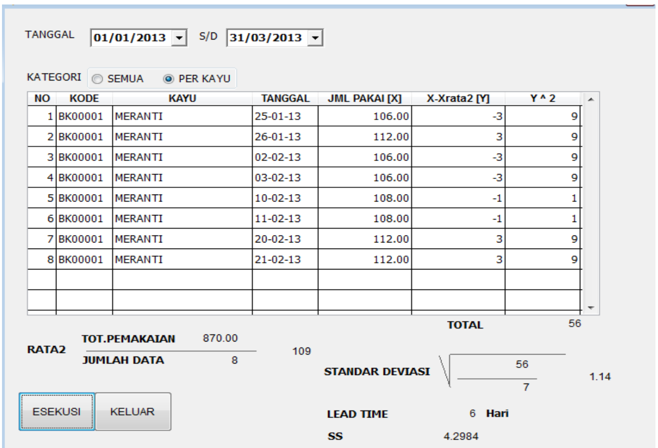


Figure 2. Calculation of Safety Stock quarterly

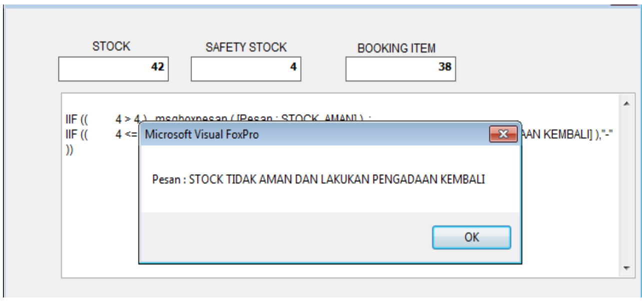


Figure 3. Usage Rule based forward chaing

## 5. Conclusion

In monitoring the raw material supply is done every day to check the stock position free, this is done by involving rule-based forward chaining and to perform safety stock calculations performed quarterly in a year. This was done to evaluate the demand patterns of consumers of each type of door that involve timber.

## Bibliography


[1] Adegoke, G.K., Aimufua, G.I.O., Jegede, A.J., 2012, Computer modelling and simulation for inventory control. *Research Journal of Applied Sciences, Engineering and Technology 4(13): 1828-1832*.

[2] Brander, P., and Forsberg, R., 2005, Determination of safety stocks for cyclic schedules with stochastic demands, *Int. J. Production Economics 104. 271–295.*

[3] Dai, H., and Tseng, M.M., 2012, The impacts of RFID implementation on reducing inventory inaccuracy in a multi-stage supply chain, *Int. J. Production Economics 139. 634–641*

[4] Funaki, K., 2010, Strategic safety stock placement in supply chain design with due-date based demand, *Int. J. Production Economics 135. 4–13.*

[5] Kulkarni Samak S.M., and Rajhans.N.R., 2012, Determination of Optimum Inventory Model for Minimizing Total Inventory Cost, *Procedia Engineering 51 803 – 809.*

[6] Shrestha, A., Anderson, A., Moore, D.W., 2012, Using point-of-view video modeling and forward chaining to teach a functional self-help-skill, *J Behav Educ 22:157–167 DOI 10.1007/s10864-012-9165-x.*

[7] Thomopoulos, N.T., 2006, Safety Stock comparison with Availability and Service level, *The* International *Applied Business Research (IABR) Conference in Cancun, Mexico.*

[8] Tratar, L.F., 2009, Minimising inventory costs by properly choosing the level of safety stock, *Economic and business review vol. 11 no. 2. 109–117* .

[9] Venkatraman, R., and Venkatraman, S., 2000, Rule-based system application for a technical problem in inventory issue, *Artificial Intelligence in Engineering 14. 143–152.*

[10] Vranes, S., Stanojevic, M., Stevanovic, V., 1996, BEST-based expert diagnostic system for the aluminum industry,*Computers in Industry 32. 53-68.*