SAFETY STOCK DETERMINATION *BASED ON DISTURBANCE CONTROL MODEL AT PT DEE*

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ABSTRACT

Uncertainty of supply and demand also internal disturbances in production system is faced by PT DEE, a food company producing beef sausage. The company find difficulties in determining safety stock for raw materials and finished products in their production operations. There is a significant excess inventory also a significant supply shortages at the company. Safety stock based on Disturbance Control Model become solution which is expected can control the disturbance of the production system. This model includes Disturbance Control Action sub model, Disturbance Advanced Policy Control sub model and Inventory Tolerance sub model to update the value of safety stock of raw materials and finished products. In this paper we will discuss the use of the model related to PT. DEE's problem.

***Keywords**: production system, food industry, disturbance, model, safety stock.*

1. INTRODUCTION

Food industry became one of the major industries in the number of companies and value added . In the food industry, there is production process did the change of inputs into production outputs which are processed in an internal system called the production system .

Availability of production inputs which are perishable and seasonal influenced the production continuity and smoothness. Interaction between internal production inputs in the production system decreases the efficiency of production . The decline in production efficiency getting worse when the input supply is not maximum. Besides that the uncertainty of demand becomes another major factor in aggravating the condition of production efficiency. Uncertainty in supply and demand conditions faced by the company coupled with the internal disruption of production systems becomes a problem for companies engaged in the food sector.

The decline in production efficiency effect in fulfilling customer demand. To deal with the uncertainty, we need safety stock. Safety stock is a solution for companies producing food for controlling the production system disorders .

The production system disorders cause deviation (variance) between planning and actual conditions . Deviations will lead to inefficiency and hinder the achievement of the target companies that reduce productivity in the company. This deviation will be one of the factors to be considered for control activities disruption of production systems in the food industry. Information on production irregularities that occurred just as well be the input to be considered in the planning of production and inventory

There are several studies related to the use of adaptive models for inventory control activities to obtain maximum performance production systems related to internal and external uncertainties.

Burt and Kraemer in Fransoo (1994) suggest strategies to use safety stock in anticipate output varies because of the raw materials varies. The variability of the quality of the raw materials are also often used as information to determine which products will be generated. When the obtained quality is not standard, it can be done reorder or recycling process that led to shortages of supplies.This inventory shortages can be controlled by safety stock.

According to Kim, et.al. (2005), uncertainties inherent in customer-demand patterns make it difficult to satisfy customer demands resulting in loosing sales opportunities or keeping excessive chain-wide inventories. In modelling inventory-control problems, it is not practical to assume that customer demands during a period are known a priori in the form of a constant or a statistical distribution. In this respect, adaptive inventory control in supply-chain management should be addressed. By adaptive, it means that the control parameters of inventory-control models are dynamically adjusted toward satisfying a target service level with the consideration of the nonstationarity of customer demand. The inventory-control parameters are safety lead time and safety stocks, respectively. The researcher using a reinforcement learning technique called action-value method, the control parameters which are designed to adaptively change as customer demand patterns changes.

Mula et al. (2006) convey various forms of uncertainty that affect the production process are categorized into two major groups, namely: Environmental uncertainty: uncertainty include demand and supply uncertainty and uncertainty System, including the following: operation yields uncertainty and production lead time uncertainty. In the paper , he formulated various models of uncertainty in the manufacturing system, among others, utilizing the concept of safety stocks and safety lead time.

Safety stock is inventory carried for the purpose of satisfying demand that exceeds the amount forecasted for a given period. It is an important measures for node enterprises managing uncertainty in a supply chain to hold safety stocks. The appropriate level of safety inventory is determined by the uncertainty of demand or supply factor and the desired level of product availability factor. As the uncertainty of supply or demand grows, the required level of safety inventories increases.

Safety stock is a stock that provided with the aim to meet the demand beyond the amount of inventory forecasting results in a period. Determination of safety stock should be minimized without reducing service levels to customers (Man - Yi et al , 2006). In companies that use production systems with strategies make to stock , the amount of inventory and safety stock products should be regulated and controlled

Marie , at.al (2011) proposed a model of the disturbance control collaborated with adaptive PPIC models to deal with uncertainty in the food industry. The variability rate of raw materials in production process of food industry could potentially lead to disturbance in the internal system of production process, and later causes the execution of production does not match the production plans, so it is necessary to update the inventory system with a shift in production plans. Considering the dynamics of market demand and the need to control disturbance in operational production system, the agroindustry with its special characteristics requires the utilization of reliable models that can support the PPIC activities. The „adjustment" of PPIC should be done immediately so as not to disturb the fulfillment of consumer demand.

The design of Adaptive PPIC model being developed based on operational condition of production system in food industry. The design of Adaptive PPIC Model of Food Industry has a PPIC submodel collaborated with disturbance control model suitable for the food industry. The Disturbances Control Model incorporating Operational Disturbances Control Model and Inventory Tolerance Model. The models can help in controlling the disturbances occurred and updating the % Loss Raw Material and % Loss Finished Good to adapt the PPIC System. The Inventory Tolerance Model is useful to calculate percentage of variance and the calculation of Loss RM percentage and Loss FG percentage based on the results of variance percentage calculation. The variance percentage calculation is done periodically and will update the percentage Loss RM and Loss FG that will be included as one of the summin factors in PPIC Model. With the updated percentage of Loss RM and Loss FG periodically, means the periodic PPIC adjustment process has been implemented thus it is called Adaptive PPIC model.

PT. DEE is a company which produces ready-to- cook foods such as beef sausages located in Sentul , Bogor . The company has a business policy to meet the customer's

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response is based on the strategy make to stock. Based on the identification of known problems that companies sometimes have a significant excess inventory in a period and other periods experiencing significant supply shortages. Excess inventory caused companies have difficulty in placing the finished product so that the finished product should not be placed in there . This leads to a decrease in the quality of food products faster. Conditions of supply shortages led to the company suffered lost sales conditions causing customers become not loyal .

This study aims to model applications Control Disorders production systems in the food industry as a solution to solve the problems in the production system disorders PT . DEE .

2. THEORETICAL BACKGROUND

2.1 Safety Stock

Service Level is the possibility that the supply shortage will not occur during the lead time . If demand varies little around the average demand , safety stock is small and vice-versa . Variability is measured by the probability distribution indicated by the average value and variance .Safety stock is determined by the management to consider the service level (Tersine,1994).

2.2 Food Industry Production System Disturbances

Disturbances that occur in the food industry are grouped into internal disturbances and external disturbances (Marie , 2012).

Internal disturbances is a disorder that arises due to internal factors of the company . Examples include: the unavailability of production capacity due to the unavailability of energy inputs to production, the input engine working hours, man hours and unavailability of raw materials , delays and interruptions in the production process due to limited production inputs or human error (planning error, error information delivery, data recording errors, miscalculations, errors set up the machine, carelessness/ negligence of the operator in the production or engine damage due to age restrictions wear).

External disturbances (supply & demand) is a disorder that arises due to factors that come from outside the company .

Examples include: the supply of raw materials exceeds the maximum limit (due to error or unilateral policy by the supplier) which causes excess inventory position , the supply of raw materials is less than the order based planning due to supplier problems that led to the position of a shortage of raw materials or raw material prices soar causing a reduction in the size of the raw material ordering than normal.

2.3 Disturbance Control Model

Disturbance Control Model is a model consisting of the Disturbances Action Control Sub Model , Disturbances Advanced Policy Control Sub Model and Inventory Tolerance Sub Model .

Disturbances Action Control Sub Model generate recommendations interference control action using the protocol mechanism or rule base . Disturbances Advanced Policy Control Sub Model generate further policy decisions interference control . Inventory Tolerance Sub Model generate safety stock value using the Disturbances Average Method. Disturbance Control Model is expected to control the production system disorders that occur in the industry and become a solution to solve the problems in the food industry prone to interference (Marie, 2011).

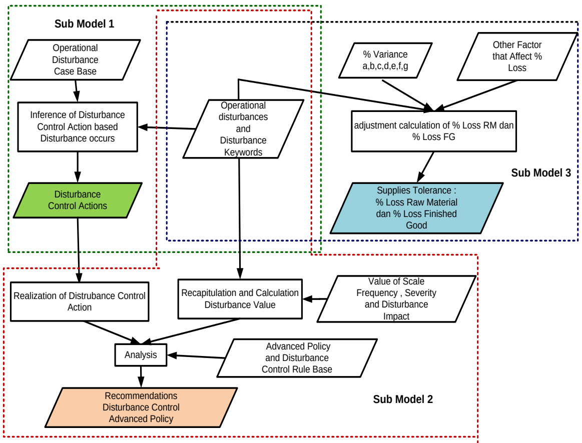

Figure 1. Interrelationship between disturbances control sub model

Specification:

a. variance a is a deviation between the Purchase Order (PO) item products demand forecasts with actual sales .
b. Variance b is the deviation between the PO raw material suppliers to the receipt of raw materials from the actual suppliers.
c. Variance c is the deviation between the amount of raw material inventory calculation results with the raw material requirements planning Inventory.
d. Variance d is the deviation between the planned production output Master Production Scheduling with actual production.
e. Variance e is the deviation between the target completion time of production based production scheduling with makespan actual production.
f. Variance f is a deviation between the distribution plan to order with the acceptance of the actual distribution.
g. Variance g deviation between the travel time distribution channels of distribution planning results with the actual travel time distribution.

Inventory Tolerance Sub Model serve to renew / update the value of safety stock as a function of safety stock . Determination of safety stock is done by using a different approach in determining the value of safety stock are generally carried out. Determination of safety stock is proposed to be more adaptive periodically considering the production system disturbances that occur (interruption of supply, demand disturbances and internal disruption of production systems).
Adaptive safety stock value will be the value of inventories tolerance (% loss), which also will adapt the model PPIC . Figures % Loss will be updated by considering the following :

a. Operational disruptions occur production system
b. Deviations/variances are due to interruption of production systems associated with sub-models PPIC recommendations.
c. Other factors that also affect change %Loss Raw Materials (%LossRM) or %Loss Finished Good (%LossFG).

Flowchart of Calculation % Loss in Inventory Tolerance Sub Model is in accordance with the following figure .

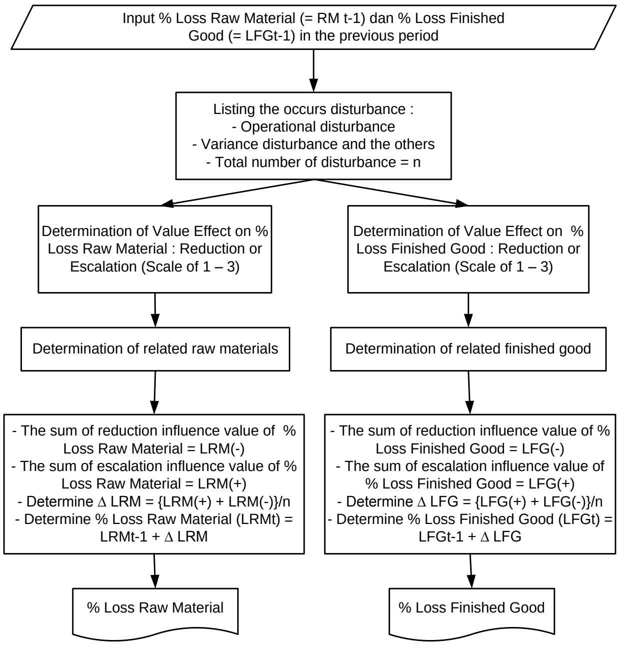

Figure 2 Flowchart of Calculation % Loss in Inventory Tolerance Sub Model

3. RESEARCH METHOD

Based on field studies and literature study, we determined the purpose of research which is to determine safety stock for HBS products in PT. DEE using Disturbance Control Model. Next, we performed data collecting and processing Disturbances Control Model . The results will be analyzed so we can get the conclusion (see Figure 3).

4. RESULT AND DISCUSSION

4.1 Determination of Safety Stock at Company today

Safety stock of finished products and raw material excess and deficiency is a problem companies that need solutions. Currently companies do not know exactly how much is the right safety stock to supply raw materials and finished products. The Company determines the safety stock based on the projected customer demand. Safety stock of finished products is set at 30 % of the projected demand in the relevant period and then reduced to the stock of finished products available. Similarly, the safety stock of raw materials, which are determined based on 15 % The Company determines the safety stock based on the projected customer demand of the projected demand in the relevant period less the stock of raw materials available.

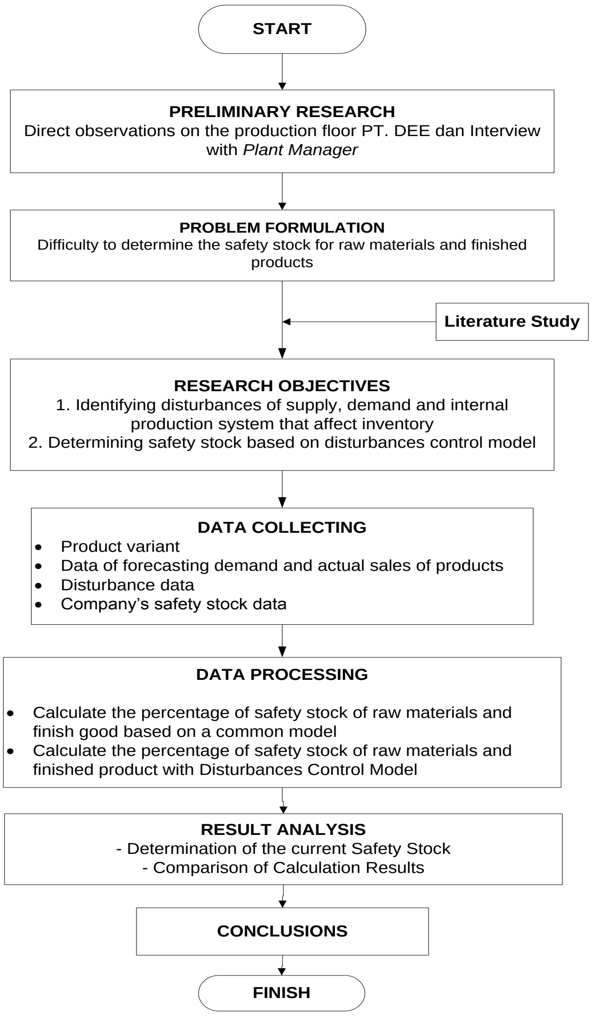

Figure 3. Research Method Flowchart

4.2 Determination of Safety Stock by General Formula

In this study the data used to have a normal distribution. If the data used normal distribution, then to determine the optimal safety stock can be directly calculated by the following formula (Tersine , 1994) :

$$S = Z\,\sigma \qquad (1)$$

Notation :
S : Safety Supplies
Z : The standard deviation of normal
σ : Standard deviation of demand

By using the above formula then get a safety supply calculation as follows :

Z = 2.03 (normal distribution conditions)
σ = 3609 units
S = 2.03 (3609) = 7326 Unit

If the result is entered into the calculation of the current condition of the company 's stock will be :

Table 1 Calculation of Raw Material Safety Stock using General Model

RAW MATERIAL		
Common Model (Tersine, 1994)		
Period	July 2014	August 2014
Previous Period Stock (kg)	1.675	3.897
Forecasting Current Month (kg)	5.513	2.400
Safety Stock Planning (kg)	1905	1905
Actual Safety Stock Production (kg)	230	0
Actual Usage (kg)	3.521	1.921
Current Month Stock (kg)	3.897	4.376

Table 2 Calculation of Finished Good Safety Stock using General Model

FINISHED GOOD		
Common Model (Tersine, 1994)		
Period	July 2014	August 2014
Previous Period Stock (kg)	0	10.094
Forecasting Current Month (kg)	16.311	9.231
Safety Stock Planning (kg)	7.326	7.326
Actual Safety Stock Production (kg)	7.326	0
Demand (kg)	13.543	7.387
Actual Sales (kg)	13.543	7.387
Current Month Stock (kg)	10.094	11.938

4.3 Application of Inventory Tolerance Sub Model

Safety stock in this sub- models will be named percent loss (% Loss) . Divided into two , namely % Loss RM for safety stock of raw materials and % Loss FG for safety stock of finished products . The function of % loss is to add (if positive) or subtract (if the result is negative) the % safety stock periodically figures set by the company.

Figures % loss will be updated (updated) by considering the following :

a. Internal disruption of production systems that occur
b. Deviation (variance) are due to interruption of production systems related to the disorder .

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c. Other factors that also affect or change % LossRM and % LossFG

The following table lists the results of the Inventory tolerance calculation at PT. DEE. Inventory results are used to perform calculations % lossRM for beef and raw materials to finished product % lossFG for SSH will periodically change associated with the production system disturbances that occur in the company. The process of calculating % LossFG and % LossRM according to Figure 2

The process of calculating % Loss RM and % LossFG will determine the safety stock of raw materials and finished products beef SSH in the next month which is used in the calculation of production planning activities in the company.

Table 3. Example of Inventory Tolerance Sub Model Calculation at PT. DEE

Keyword	Source							Influence Value of % *safety stock*			
	S	Internal Production System					D	RM Up	RM Down	FG Up	FG Down
		IPS-1	IPS-2	IPS-3	IPS-4	IPS-5					
Raw Material		√						1	0	0	0
Raw Material		√						3	0	0	0
Policy						√		0	0	2	0
Supply	√							3	0	0	0
Machine			√					2	0	2	0
Machine			√					0	0	0	0
Raw Material						√		3	0	0	0
General						√		0	0	0	3
Operator				√				2	0	0	0
Machine						√		2	0	0	0

Beef Raw Material			Beef Sausage Finished Good		
Total	Up	Down	Total	Up	Down
	23	3		9	6
Δ	20		Δ	3	
Average	1,33%		Average	0,20%	
% Loss Previous Period	13,34%		% Loss Previous Period	32,93%	
% Loss This Periode	14,67%		% Loss This Periode	33,13%	

% safety stock of finished good products for this period is 27.07%. There is an positive influence for next period is 0.20%, so % safety stock for the next period is 27.27% .

% safety stock of raw material this period is 13.34%. There is an influence for next period is 1.33% so % safety stock next period is 14.67%.

% safety stock of finished products of this period is 27.07 %, % influence the finished product next period is 0.20 % so % safety stock next period is 27.27 %.

% safety stock of raw material this period is 13.34 %, % raw material influence the next period is 1.33 % so % safety stock next period is 14.67 %

The applied of Disturbance Control Model will generate an adaptive safety stock based on the company's condition as shown by the following table.

Table 4. Comparison of Raw Material Safety Stock Calculation – Current vs Proposed

RAW MATERIAL			RAW MATERIAL		
Proposed Improvement Condition			Current Condition		
Period	July 2014	August 2014	Period	July 2014	August 2014
Previous Period Stock (kg)	1.675	3.667	Previous Period Stock (kg)	1.675	3.667
Forecasting Current Month (kg)	5.513	2.400	Forecasting Current Month (kg)	5.513	2.400
Safety Stock Planning (kg)	766	351	Safety Stock Planning (kg)	827	360
Actual Safety Stock Production (kg)	0	0	Actual Safety Stock Production (kg)	0	0
Actual Usage (kg)	3.521	1.921	Actual Usage (kg)	3.521	1.921
Current Month Stock (kg)	3.667	4.146	Current Month Stock (kg)	3.667	4.146

Table 5. Comparison of Finish Good Safety Stock Calculation – Current vs Proposed

FINISHED GOOD			FINISHED GOOD		
Proposed Improvement Condition			Current Condition		
Period	July 2014	August 2014	Period	July 2014	August 2014
Previous Period Stock (kg)	0	7.288	Previous Period Stock (kg)	0	7.661
Forecasting Current Month (kg)	16.311	9.231	Forecasting Current Month (kg)	16.311	9.231
Safety Stock Planning (kg)	4.520	2.536	Safety Stock Planning	4.893	2.769
Actual Safety Stock Production (kg)	4.520	0	Actual Safety Stock Production (kg)	4.893	0
Demand (kg)	13.543	7.387	Demand (kg)	13.543	7.387
Actual Sales (kg)	13.543	7.387	Actual Sales (kg)	13.543	7.387
Current Month Stock (kg)	7.288	9.132	Current Month Stock (kg)	7.661	9.505

In the table above it can be seen that the supply conditions of the proposed less than current conditions .

Disturbance Control Model Application need an information system and database servers to accommodate the interference so that it can be easily searched and updated.

By the model we can determine the right safety stock which is constantly updated based on the conditions of uncertainty of supply, demand and production system disturbance that occurs.

There is a disadvantages of the Disturbance Control Model that safety stock calculation requires the determination of parameter values for many items. To get the calculation result easier to get the results we have to continuously updating the data in accordance with the dynamics uncertainties occur. We require supporting information

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systems in order to maximize the utilization of of the model.

5. CONCLUSION

Determination of safety stock using disturbances control model helps companies to obtain the optimal level of safety stock in based on company's production system disturbances. This makes the company does not have the condition of lost sales or excess inventory that is too high, so the value of the cost savings can be suppressed and production efficiency can be maintained.

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