DEMAND FORECASTING FOR SALES ORDER AND DISTRIBUTION REQUIREMENTS PLANNING SYSTEM (CASE STUDY : IKM XYZ)

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ABSTRACT

Industrial Engineering and Informatics Engineering Departments of University Al Azhar Indonesia have formed a collaboration to support IKM XYZ – a moslem fashion production company - addressing its Distribution Requirements Planning (DRP) problem. The system itself consists of two main parts : the orders predictions for each of 20 main distributors and the DRP itself. This paper is focusing on the first part with the intention to forecast the orders of the product for the specific period on the future based on the main distributor's history of orders data.

***Keywords**: demand forcasting, distribution requirements planning (DRP).*

1. INTRODUCTION

1.1. Background

IKM XYZ is a moslem fashion production company placed in east of Jakarta and currently is servicing its 20 main distributors in Indonesia. Among the main issues found in the IKM XYZ are the lack of integration of its important data such as the models, the volume of each models, the demand for each distributors, the materials, the productions, the employees. Its also found that there is no computerized connection between IKM XYZ to its distributors and the production division so that IKM XYZ frequently fail to fulfill its distributors orders of their best sellers products because of the 'unpredictable' characteristic of the demands

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1.2. Research Objective

This research was aimed to :

a. Predicting the amount of demand (demand forecasting) of goods from a distributor in order to predict how much the demand for goods in the next period.
b. Estimating when and how many products must be ordered by IKM XYZ to the production in order to secure the stocks of goods.

1.3. Limitations

The Sales Order and Distribution Requirements Planning (SO&DRP) System had been built. For the sample of process that will be shown here, the system will execute to examine :

a. five types of best sellers products and five distributors that stable in an order of goods and payment of invoices at IKM XYZ based on IKM XYZ's owner opinion.
b. Only counting demand forecasting for goods with no attention to their size and color.

1.4. Assumptions

The system built with a few assumpsions deal with :

a. Nine alpha parameters, namely 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9.
b. there are 4 weeks within 1 month, and above the 28th of date in a month will be assume as the 4th week.

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1.5. Research Methods

These methods has used to conduct the research :

a. Primary data was collected through direct observation to the factory and interviewing the distributor and the employees.
b. Software was built using System Development Life Cycle (SDLC) methodology.

2. THEORETICAL BACKGROUND

2.1 Forecasting Definition

Forecasting is the estimate activity or predict what happens in the future, while the plan is determining what will be done in the future. Forecasting is very important for the preparation of a plan of which is based on a projection or forecasting. (Annisa, 2010)

Forecasting aiming to get the forecasting results that can minimize errors predict (forecast error) and usually measured by the mean square error, mean absolute error, and so on. (Annisa, 2010)

The usefulness of forecasting visible at the time of decision making. Good decision is a decision based on considerations that will occur at the time the decision was implemented. The success of a forecasting is largely determined by (Annisa, 2010) :

a. Engineering knowledge about the collection of information (data) of the past, the data or the information is quantitative.
b. Techniques and methods that remain and in accordance with the patterns of data that have been collected.

Demand measurement is an attempt to determine the demand for a product or group of products in the past and in the future now in particular constraints of the asset condition. Demand forecasting is an attempt to determine the amount of a product or group of products in the future within the constraints of the assets of certain conditions. The most out of an forecasting activity is to conduct the minimization of uncertainty that may occur in the future. (Annisa, 2010)

1.1 Forecasting Methods

Forecasting method is a way of estimating in quantitatively or qualitatively what will happen in the future, based on the relevant data in the past. Usefulness forecasting method is to estimate systematically and pragmatically based on the relevant data in the past. Thus forecasting is expected to provide greater objectivity. Forecasting methods provide sequence and solve problems in forecasting approach, so that when it is used the same approach to the problem, it will get the rationale and solving the same argument. (Annisa, 2010)

The classification of forecasting methodes can be seen at figure 1 below.

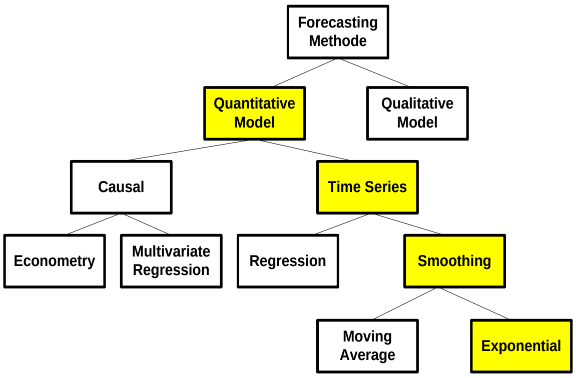


Figure 1. Forecasting Methodes

One of the approach in forecasting is time series. Time series approach is a model which does not consider the causal relationship or in other words just notice to the tendency of forecasting results from past data that available. (Annisa, 2010)

Quantitative forecasting is a forecasting based on quantitative data from the past. Forecasting results that made are very depends on the method used in the forecasting. Quantitative forecasting can be applied with the following conditions (Dalimunthe, 2012) :

a. Information (data) about the past is available.
b. The information (data) can be used as quantitative in numerical data form.

It can be assumed that some aspects of the past pattern will continue in the future.

Time series approach is a model which does not consider the causal relationship or in other words just notice to the tendency of forecasting results from past data that available. (Annisa, 2010)

Smoothing Time Series Forecasting is a method of forecasting with smoothing held against past data by taking the average of the value at some period to assess the value in a period. (Dalimunthe, 2012)

Exponential smoothing method is the development of moving averages methods. In this method of forecasting is done by continuously repeating the calculation using the latest data. In this method, determining the forecast process will starts with determining the alpha value by trial and error. While the stages in determining the forecast is as follows. (Raharja, -)

1) Determine the 1st Smoothing (S'_t)
$$S'_t = \alpha X_t + (1 - \alpha)\, S'_{(t-1)} \quad (1)$$
2) Determine the 2nd Smoothing (S''_t)
$$S''_t = \alpha S'_t + (1-\alpha) S''_{(t-1)} \quad (2)$$
3) Determine a_t value (a_t)
$$a_t = 2S'_t - S''_t \quad (3)$$
4) Determine the slope (b_t)
$$b_t = (\alpha / (1 - \alpha))\ (S'_t - S''_t) \quad (4)$$
5) Determine the *forecast* $F_{(t+m)}$
$$F_{(t+m)} = a_t + b_t\,(m) \quad (5)$$

Information (Raharja, -) :
- X_t = the actual value of the observation (data history)
- S = overall smoothing
- F = forecasting for *m* future period (forecasting for future)
- t = time indicating the current index
- α , β = constants that must be estimated in order to minimize errors. Error that shows how much difference there is the estimation with the value to be estimated.

The results of accurate projections are forecast that could minimize errors predict (forecast error). The amount of forecast error is calculated by subtracting the amount of real data with forecasts.

$$\text{Error (E)} = X_t - F_t \quad (6)$$

Information (Dalimunthe, 2012) :
F_t = forecasting of *t* periods

Mean Absolute Percentage Error (MAPE) is the middle value of absolute percentage error of a forecasting (Annisa, 2010).

$$\text{MAPE} = \sum |\text{APE}| / n \quad (7)$$

Information :
APE = *Absolute Percentage Error* which is the total of the formula (2.6)
n = the number of demands data

3. RESEARCH METHOD

3.1 The Existing System

It had found through interviewing the employees and observing the factory that the distributors was ordering the goods with traditional methods using telephone, SMS (Short Message Service), or BBM (BlackBerry Messenger).

Every incoming order data will be recorded in a ledger based on models of clothes, and not based on the distributor who ordered. This kind of process made it difficult to tracking the data orders based on each distributor.

Other problem was that the XYZ often failed to fulfill the order from distributors, especially for best-seller products. Demand from each distributor can not be predicted with certainty how much due to the data history of demand in previous periods spread over the different files.

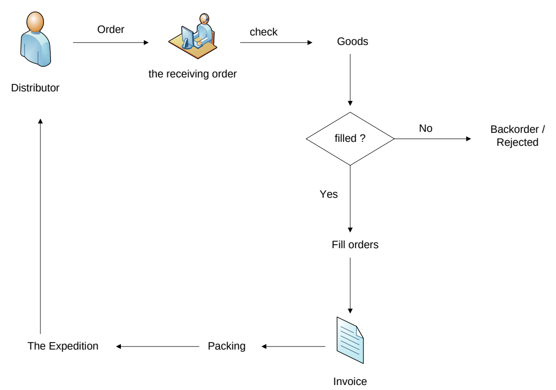


Figure 2 The Existing System

3.2 The System Design Proposed

The new Sales Order and Distribution Requirements Planning (SO&DRP) had been built with actors involved :

a. *Distributor* : the actor / user who will order and receive goods.
b. *Marketing* : the actor / user in charge of receiving orders. In addition, the marketing also regulating the invoice / distributors bill. Marketing also have a

roles as mediator between IKM XYZ with distributors.

c. Warehouse Operators : the actor / user in charge of managing the data contained goods inventory in the warehouse, perform forecasting and scheduling needs of the distribution of goods, and order goods to production.

Figure 3 shows the new SO&DRP system with these 3 main users.

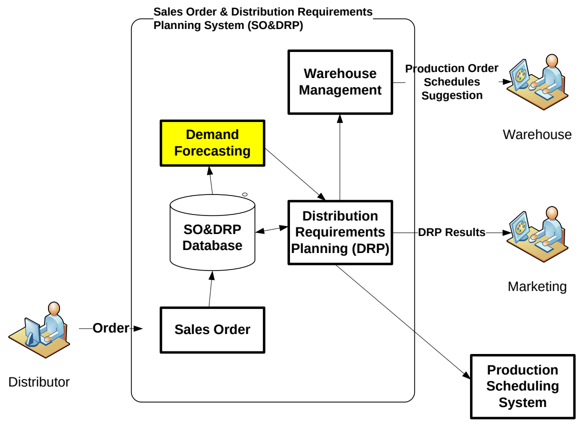


Figure 3 Sales Order and Distribution Requirements Planning (SO&DRP) System

3.3 Forecasting Algorithm

There are 16 steps to get the forecast result:

a. Taking the history of products data.

b. Initialize the value of the overall smoothing (smoothing = demands).

c. Calculate a_t , where a_t = S'_t + (S'_t – S''_t) = $2S'_t$ – S''_t.

d. Calculate b_t , where b_t = (α / (1 – α)) (S'_t – S''_t).

e. Calculate the forecasting of F_t, where $F_{(t+m)} = a_t + b_t$ (m)

f. Calculate the single exponential smoothing S'_t , where $S'_t = \alpha X_t + (1 - \alpha) S'_{(t-1)}$

g. Calculate the double exponential smmothing S''_t , where $S''_t = \alpha S'_t + (1 - \alpha) S''_{(t-1)}$

h. Calculate a_t.

i. Calculate b_t.

j. Calculate forecasting F_t.

k. Calculate the *error* in each period.

l. Repeat steps 6 through 11 for the next period.

m. Calculate the four forecasting future periods.

n. Calculate the value of the overall error (MAPE).

o. Calculate the MAPE value for each other alpha (α) .

p. Taking the smallest MAPE.

4. RESULT AND DISCUSSION

4.1 Database

Figure 4 shows 17 tables of the SO&DRP system. For the forecasting itself, it used only 6 among the tables : Hasil Peramalan, Distributor, Produk, Kategori Produk, Detail Order, and Pemesanan.

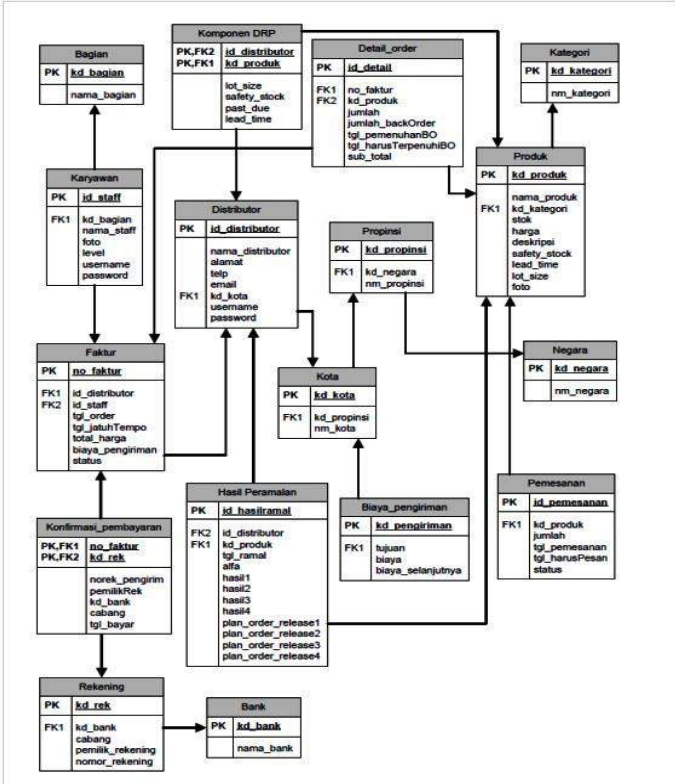


Figure 4. Logical Record Structure for SO&DRP System

4.2 User Interface SO&DRP System

For running the forecasting process, user should choose the name of distributor and the product. User faces the screen as the figure 5 below.

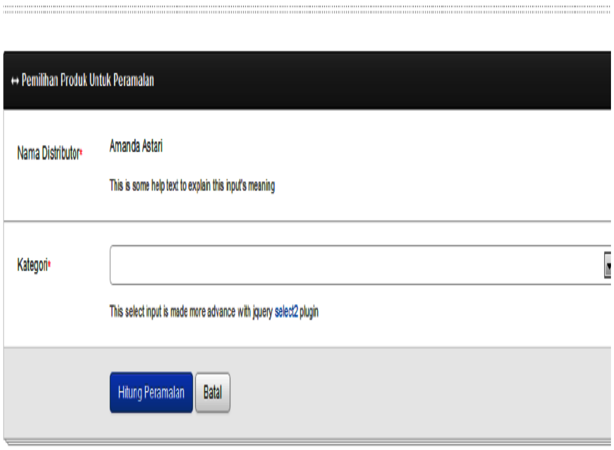


Figure 5. Screen for Activating the Forecasting Process

After doing that, system will begin counting the demand forecasting based on the history of order data at the database. The result of all of nine alpha parameters can be seen as figure 6.

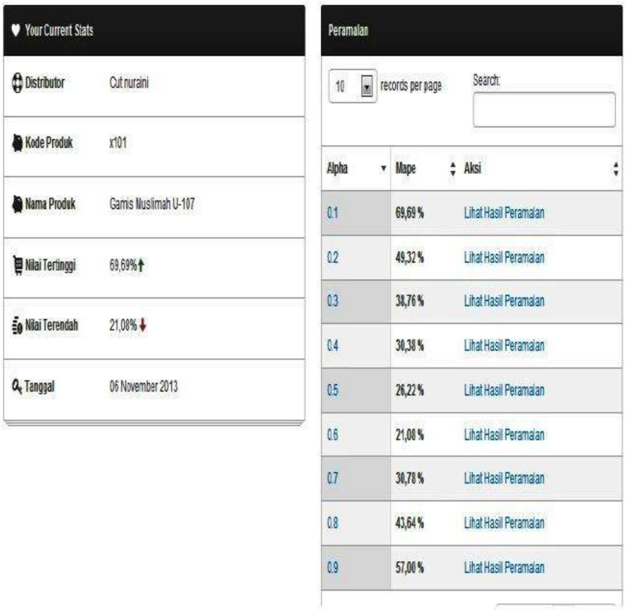
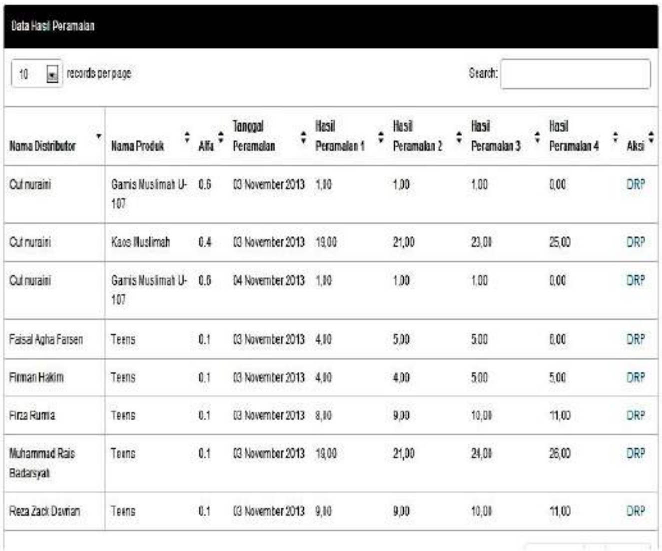


Figure 6. Screen of Choosing MAPE Forecasting Results

Later, user can choose one of nine results which shows the lowest of MAPE number. After that, the forecasting result will be shown as figure 7 shows for 4 weeks order prediction.


Data Hasil Peramalan

10 records per page　Search:

Nama Distributor	Nama Produk	Alfa	Tanggal Peramalan	Hasil Peramalan 1	Hasil Peramalan 2	Hasil Peramalan 3	Hasil Peramalan 4	Aksi
Cut nuraini	Gamis Muslimah U-107	0.6	03 November 2013	1,00	1,00	1,00	0,00	DRP
Cut nuraini	Kaos Muslimah	0.4	03 November 2013	19,00	21,00	23,00	25,00	DRP
Cut nuraini	Gamis Muslimah U-107	0.6	04 November 2013	1,00	1,00	1,00	0,00	DRP
Faisal Agha Farsen	Teens	0.1	03 November 2013	4,00	5,00	5,00	0,00	DRP
Firman Hakim	Teens	0.1	03 November 2013	4,00	4,00	5,00	5,00	DRP
Firza Rumia	Teens	0.1	03 November 2013	8,00	9,00	10,00	11,00	DRP
Muhammad Rais Badarsyah	Teens	0.1	03 November 2013	19,00	21,00	24,00	26,00	DRP
Reza Zack Davian	Teens	0.1	03 November 2013	9,00	9,00	10,00	11,00	DRP

Figure 7. Screen of Forecasting Result

4.3 Sample of Result

This is the forecasting for Surabaya's Distributor for products X102. Table 1 shows the history of Surabaya's order for 7 months from September 2012 until March 2013.

Table 1. Surabaya's Distributor Demands of X102 Product (Anela, 2013)

Period	Week	X102
September 2012	1	1
	2	2
	3	1
	4	1
October 2012	1	1
	2	1
	3	1
	4	2
November 2012	1	1
	2	2
	3	1
	4	2
December 2012	1	27
	2	23
	3	17
	4	12
January 2013	1	5
	2	1
	3	2
	4	3
February 2013	1	5
	2	7
	3	9
	4	8
March 2013	1	8
	2	5
	3	12
	4	20

Executing the system with this data can resulting the forecast as can be seen from table 2. There are 4 forecast result. Week 1 to 28 are the history data, week 29 and after are the forecast results. So for Surabaya distributor for product X102 it can be predicted that on weeks 29, 30, 31, 32 Surabaya will order 19, 21, 23, and 26 items respectively.

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Table 2 Forecasting results the Surabaya's Distributor from X102 Products With Alpha Value = 0.4

Period	Demand	S'	S"	a	b	Ft	Error
1.	1	1.00	1.00	1.00	0.00	0.00	0.00
2.	2	1.40	1.16	1.64	0.16	1.80	0.10
3.	1	1.24	1.19	1.29	0.03	1.32	0.32
4.	1	1.14	1.17	1.12	-0.02	1.10	0.10
5.	1	1.09	1.14	1.03	-0.03	1.00	0.00
6.	1	1.05	1.10	1.00	-0.03	0.97	0.03
7.	1	1.03	1.07	0.99	-0.03	0.96	0.04
8.	2	1.42	1.21	1.63	0.14	1.76	0.12
9.	1	1.25	1.23	1.27	0.02	1.29	0.29
10.	2	1.55	1.36	1.74	0.13	1.87	0.06
11.	1	1.33	1.35	1.31	-0.01	1.30	0.30
12.	2	1.60	1.45	1.75	0.10	1.85	0.07
13.	27	11.76	5.57	17.95	4.12	22.07	0.18
14.	23	16.26	9.85	22.67	4.27	26.94	0.17
15.	17	16.55	12.53	20.58	2.68	23.26	0.37
16.	12	14.73	13.41	16.05	0.88	16.94	0.41
17.	5	10.84	12.38	9.30	-1.03	8.27	0.65
18.	1	6.90	10.19	3.62	-2.19	1.43	0.43
19.	2	4.94	8.09	1.79	-2.10	-0.31	1.15
20.	3	4.17	6.52	1.81	-1.57	0.24	0.92
21.	5	4.50	5.71	3.29	-0.81	2.48	0.50
22.	7	5.50	5.63	5.37	-0.09	5.29	0.24
23.	9	6.90	6.14	7.66	0.51	8.17	0.09
24.	8	7.34	6.62	8.06	0.48	8.54	0.07
25.	8	7.60	7.01	8.20	0.39	8.59	0.07
26.	5	6.56	6.83	6.29	-0.18	6.11	0.22
27.	12	8.74	7.59	9.88	0.76	10.64	0.11
28.	20	13.24	9.85	16.63	2.26	18.89	0.06
29.	Forecasting Results : n - period					18.89 (m=1)	
30						21.15	
31.						23.41	
32.						25.67	
MAPE = 25.01 %							

5. CONCLUSION

a. With this forecast system, XYZ co. Could know when and how much items that must be produced.
b. Demand forecasting is based on history of data orders so the company has to commit to entry all of their orders data. But, a lack of data as much as 5 % will be a little effect to this method because of the smoothing process.
c. To be implemented, we have to pay attention to time scheme in a year. This forecasting use 4 weeks per month that lead to 48 weeks per year. Improving this time scheme to 52 weeks will make this system more accurate to be used.

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7. REFERENCES

(a) Chang, T. C., Anderson, D. C., Mitchell, O. R. (1989) QTC - and integrated design/manufacturing/inspection system for poismatic parts. *Proceedings of the ASME Conference on Computers and Engineering, San Francisco, CA,* 417-426.
(b) Dalimunthe, Dzulfiqar Ammario. (2012). Analisis Korelasi Pola Masuk UKM ke Dunia Bisnis (Studi Kasus pada Pajak USU Medan). Prodi Manajemen, Fakultas Ekonomi, Universitas Sumatera Utara.
(c) Annisa, Nurul. (2010). Peramalan Hasil Penjualan Minyak Sawit di Sumatera Utara Tahun 2010 Berdasarkan Data Tahun 2003 s/d 2008, Prodi D-3 Statistika, Universitas Sumatera Utara
(d) Raharja, Alda. (-) Penerapan Metode *Exponential Smoothing* Untuk Peramalan Penggunaan Waktu Telepon di PT. Telkomsel Divre3. Surabaya : Institut Teknologi Sepuluh November.
(e) Fahrozi, Adib. 2009. Perencanaan dan Penjadwalan Aktivitas Distribusi Hasil Perikanan dengan Menggunakan Distribution Requirement Planning (DRP). Jatim: Universitas Pembangunan Nasional "Veteran".
(f) Anela. 2013. Usulan Perencanaan dan Penjadwalan Distribusi dengan Metode *Distribution Resource Planning* dan Pengembangan *Excess Stock Management* pada IKM XYZ. Jakarta : Universitas Al Azhar Indonesia.

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