

# Developing Web-Based Application of Sales Forecasting System Using Triple Exponential Smoothing Method For Small and Medium Garment Enterprises

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**Abstract**—Accurate sales forecasting is needed by all companies, including by small and medium garment enterprises to be used in financial management. Accurate sales forecasting will make better inventory management, which indirectly gives benefit to the company. Limitation of human in forecasting sales without using tools in form of computer application becomes an obstacle to predict sales accurately. This study aimed at developing web-based application of sales forecasting system using triple exponential smoothing method for small and medium garment enterprises. This application was developed by using PHP programming language and the data was stored in MySQL database. Method of application development used System Development Life Cycle (SDLC) with steps: requirements analysis, design, development, and testing. Score of forecasting error level was calculated by using MAPE (Mean Absolute Percentage Error), and RMSE (Root Mean Square Error). The result of this study was web-based application of sales forecasting system using triple exponential smoothing method which was tested by using sales data of small and medium garment enterprises in January 2016 until December 2017.

**Keywords**—triple exponential smoothing; forecasting; web-based application

## I. INTRODUCTION

Determining production number is a part of strategy in financial management for Small and Medium Garment Enterprises. In determining number of productions, the company should be able to forecast the upcoming sales. If the company made mistake in forecasting the sales, there could be undesirable things happen. For example, the company could not fulfill the customer's demand which suddenly rises. Otherwise, company makes over production in which customer's demand is not equal to the company's estimation so the product cannot be sold. It can harm the company. So, sales forecast is the basis of financial planning [1].

Therefore, it is needed a computer program as the implementation of forecast method to help Small and Medium Garment Enterprises in getting the value of sales forecast

accurately and fast. One of the common methods of forecasting is the Exponential Smoothing methods. The method is very important in the statistical methods and procedures addressing noise and random errors [2]. Exponential Smoothing methods can be defined generally as fine-tuning or smoothing data where there is interference. It is a kind of estimation process which is proven through the study of cases that depend on time or change with time [3].

Method of Triple Exponential Smoothing (Brown's one parameter quadratic) is the development of two Linier Multiply exponential technique of Parameter Holt upon season by inserting third smoothing to adjust seasonal component. This method is based on quadratic function is used to forecast data by a basic trend pattern. If the data pattern basis is higher quadratic, cubic or ordo so it is used additional smoothing level (triple smoothing) and enforcing quadratic forecasting equation.

The exponential smoothing method describes a class of forecasting methods. Each has the property that forecasts are weighted combinations of past observations, where recent observations are given relatively more weight than older ones [4]. The triple exponential smoothing method provides good forecasts with simple formulations, allowing the incorporation of error, trend components in a comprehensive manner [5-8].

This study aimed at developing web-based application of sales forecasting system using triple exponential smoothing method (Brown's one parameter quadratic).

## II. METHODOLOGY

### A. Step of Application Development

The developed application is a web-based application. The method of application development used System Development Life Cycle (SDLC) with steps: requirements analysis, design, development, and testing. Application development used PHP programming language and data storage in MySQL database. Testing of application used data of sales in 2015 until 2017.

### B. Method of Sales Forecasting

The method used to forecast the sales in this application development was triple exponential smoothing method (Brown's one parameter quadratic), with the following steps.

#### 1. Calculating value of first exponential smoothing

$$S'_t = \alpha Y_t + (1 - \alpha) S'_{t-1} \quad (1)$$

#### 2. Calculating value of second exponential smoothing

$$S''_t = \alpha S'_t + (1 - \alpha) S''_{t-1} \quad (2)$$

#### 3. Calculating value of third exponential smoothing

$$S'''_t = \alpha S''_t + (1 - \alpha) S'''_{t-1} \quad (3)$$

#### 4. Calculating total smoothing

$$a_t = 3S'_t - 3S''_t + S'''_t \quad (4)$$

#### 5. Calculating trend smoothing

$$b_t = [\alpha / \{2(1-\alpha)^2\}] [(6-5\alpha)S'_t - (10-8\alpha)S''_t + (4-3\alpha)S'''_t] \quad (5)$$

#### 6. Calculating quadratic smoothing

$$c_t = [\alpha^2 / (1-\alpha)^2] [S'_t - 2S''_t + S'''_t] \quad (6)$$

#### 7. Determining value of forecasting

$$F'_{t+m} = a_t + b_t(m) + 0,5c_t m^2 \quad (7)$$

In which:

- $S'_t$  = First smoothing period t
- $\alpha$  = Smoothing Constanta ( $0 < \alpha < 1$ )
- $Y_t$  = Real value of period t or actual data
- $S''_t$  = Second smoothing period t
- $S'''_t$  = Third smoothing period t
- $a_t$  = Total smoothing
- $b_t$  = Trend smoothing
- $c_t$  = Quadratic smoothing
- $F'_{t+m}$  = Forecasting value
- $m$  = Future period

### C. Forecasting Errors

There are some methods to measure compatibility and accuracy of forecasting [9]. This study used MAPE (Mean Absolute Percentage Error), and to calculate value of forecasting error level. MAPE is absolute value from errors measurement as percentage of forecasting error [10]. Calculation formula can be seen in (1), (2), and (3). This gap is calculated in percentage upon real data.

$$PE = \left( \frac{Y_t - F_t}{Y_t} \right) (100) \quad (8)$$

$$MPE = \sum_{i=1}^n \frac{PE_i}{n} \quad (9)$$

$$MAPE = \sum_{i=1}^n \frac{|PE_i|}{n} \quad (10)$$

In which:

- $t$  = index which states time period
- $y$  = actual value
- $F$  = forecast on period m in the future
- $PE$  = Percentage Error
- $MPE$  = Mean Percentage Error
- $n$  = total of data

Mean Squared Error (MSE) is mean square score of forecast error. Formula to calculate MSE can be seen in (11). Value of Root Mean Square Error (RMSE) showed difference between forecast result and the forecasted result. Getting smaller the value of RMSE so the value of forecasting is getting accurate. Formula to calculate value of RMSE can be seen in (12).

$$MSE = \frac{1}{N} \sum_{t=h}^N (Y_t - \hat{Y}_t)^2 \quad (11)$$

$$RMSE = \sqrt{\frac{\sum (Y_t - \hat{Y}_t)^2}{N}} \quad (12)$$

In which:

- $N$  = number of samples
- $Y_t$  = actual value
- $\hat{Y}_t$  = predicted value
- $MSE$  = Mean Square Error

### III. IMPLEMENTATION

This sales forecasting application was developed by using PHP programming language (framework CodeIgniter) with MySQL database. Application flow was started from the use of inputting sales data from small and medium garment enterprises as early information of calculation. The more sales data inputted into application, the more accurate result of the forecasting is gained from the application. It is suggested that the inputted real sales data minimum 6 periods. Next the application will search  $\alpha$  optimum value by testing  $\alpha$  value from 0.001 until 0.999. There is smoothing calculation for each  $\alpha$  value with (1), (2), (3) and searches value of MSE. Optimum value is  $\alpha$  which produces the lowest MSE value. Further step is the application conducts forecasting process by using (4),

(5), (6), (7). The result of forecasting is stored in MySQL database. This application can also present forecasting error testing for the past sales data with MAPE and RMSE methods. Application Flowchart can be seen in Fig. 1.

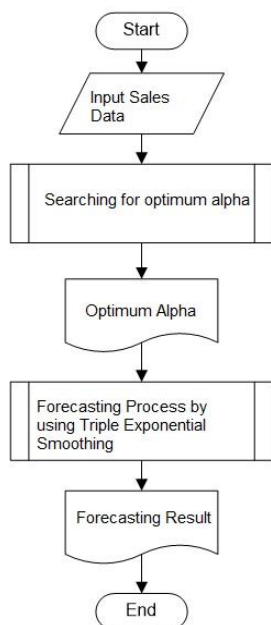


Fig. 1. Application Flowchart

Testing of this sales forecast application uses sales data from Small and Medium Garment Enterprises “CV. Sahabat Sejati Embroidery” in January 2016 until December 2017, shown in Table I.

TABLE I. SALES DATA IN JANUARI 2016 UNTIL DECEMBER 2017

Month	The Amount Sold				
	T-shirt A	T-shirt B	T-shirt C	T-shirt D	T-shirt E
Jan 2016	752	511	679	121	456
Feb 2016	950	478	365	102	308
Mar 2016	1,068	939	1,144	229	802
Apr 2016	975	635	545	348	363
May 2016	841	511	766	231	799
Jun 2016	800	876	389	105	403
Jul 2016	562	654	678	109	877
Aug 2016	343	762	783	201	899
Sep 2016	605	754	678	209	877
Oct 2016	772	899	890	109	987
Nop 2016	1,014	876	980	205	751
Dec 2016	823	743	661	210	901
Jan 2017	778	654	782	190	877
Feb 2017	686	807	867	187	766
Mar 2017	736	578	455	195	542
Apr 2017	646	799	786	206	543
May 2017	688	678	890	302	654
Jun 2017	512	899	765	210	876
Jul 2017	1,223	878	987	327	654
Aug 2017	790	765	889	267	653
Sep 2017	692	645	675	190	563
Oct 2017	777	762	761	198	456
Nop 2017	808	810	880	216	356
Dec 2017	653	859	975	321	776

Fig. 2 shows the output of the application for sales forecast using triple exponential smoothing method.

SALES FORECASTING SYSTEM

Product Name: T-SHIRT A

SALES FORECASTING

Sales forecast for January 2018 : 581  
Sales forecast for February 2018 : 472  
Sales forecast for March 2018 : 345

FORECASTING ERROR

MAPE (Mean Absolute Percentage Error) = 0.27  
RMSE (Root Mean Square Error) = 303.62

NO	MONTH	T-SHIRT A SALES	FORECASTING
1	Jan - 2016	752	0
2	Feb - 2016	950	752
3	Mar - 2016	1,068	1,062
4	Apr - 2016	975	1,233
5	May - 2016	841	1,024
6	Jun - 2016	800	750
7	Jul - 2016	562	684
8	Aug - 2016	343	356
9	Sep - 2016	605	72
10	Oct - 2016	772	589
11	Nov - 2016	1,014	948
12	Dec - 2016	823	1,303
13	Jan - 2017	778	913
14	Feb - 2017	686	736
15	Mar - 2017	736	579
16	Apr - 2017	646	683
17	May - 2017	688	582
18	Jun - 2017	512	668
19	Jul - 2017	1,223	418
20	Aug - 2017	790	1,548
21	Sep - 2017	692	869
22	Oct - 2017	777	575
23	Nov - 2017	808	717
24	Dec - 2017	653	812

Fig. 2. The output of the application

#### IV. CONCLUSION

This web-based application of sales forecasting system using triple exponential smoothing method (Brown's one parameter quadratic) was developed by using PHP programming language and the data is stored in MySQL database. This application could determine the use optimum  $\alpha$  perimeter value. This application was tested by using sales data of small and medium garment enterprises from January 2016 until December 2017. The sales forecasting error was tested by

using MAPE (Mean Absolute Percentage Error), and RMSE (Root Mean Square Error) methods.

For further study, this application can be developed by adding other forecasting method. It enables to conduct comparison analysis between some forecasting methods to get maximum result.

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