Implementation of the Trend Line Analysis Method on Newspaper Demand in the Digitalization Era: A Case Study

Hani Aninda Intan Permatasari, Muhammad Raihan Syaifudin, Safira Nariswari
Undergraduate Program in Industrial Engineering Department, Faculty of Engineering
Universitas Sebelas Maret Surakarta, Jl. Ir. Sutami, 36 A, Surakarta, Indonesia
permatasarihani301@student.uns.ac.id, raihan_syaifudin@student.uns.ac.id,
safiranariswari@student.uns.ac.id

Nida An Khofiyah
Industrial Engineering Department, Faculty of Engineering
Pelita Bangsa University, Jl. Inspeksi Kalimalang Tegal Danas, Cikarang, Indonesia
khofiyah.nidaan@gmail.com

Wahyudi Sutopo
University Centre of Excellence for Electrical Energy Storage Technology
Universitas Sebelas Maret, Surakarta, Jl. Ir. Sutami, 36 A, Surakarta, Indonesia
wahyudisutopo@staff.uns.ac.id

Yuniaristanto
Research Group Industrial Engineering and Techno-Economic, Industrial Engineering
Department, Faculty of Engineering
Universitas Sebelas Maret, Surakarta, Jl. Ir. Sutami, 36 A, Surakarta, Indonesia
yuniaristanto@ft.uns.ac.id

Abstract

The rapid development of communication and information technology has given birth to new digital-based media that have changed people's behavior in consuming mass media. Consumers are significantly moving from conventional media to digital. Print media lost readers drastically, especially from the young group. This had some negative effects on the demand for printed newspapers, with frequent supply-demand inaccuracies resulting in many newspapers being returned. For this reason, it is necessary to determine the method of forecasting the number of newspaper requests that has the smallest error rate so that it can help companies reduce losses due to newspaper returns. This study calculates demand forecasting using the trend line analysis method in three conditions, namely when demand decreases, increases, and is seasonal. Furthermore, the three conditions are compared with the forecasting results. The selection of the forecasting method for the best conditions is done by comparing the error rate (MAPE) of each condition with the trend line analysis method, then the trend line analysis method is chosen under certain conditions with the smallest error rate. Based on the comparisons made, it can be seen that the forecasting method that has the smallest error rate is the trend line analysis method with an uptrend with a MAPE value of 4.56%. Therefore, the conditions that are suitable for using the trend analysis method are obtained, namely when demand increases or has an uptrend.

Keywords
Case Study, Demand Forecasting, Digitalization Era, Newspaper Forecasting and Trend Line Analysis

1. Introduction

The rapid development of communication and information technology has given birth to new digital-based media that have changed people's behavior in consuming mass media (Aliudin and Arisanty 2018). Consumers are significantly moving from conventional media to digital. Print media lost their readers drastically, especially from the young group (Aliudin and Arisanty 2018). The presence of communication technology that is growing rapidly is a breath of fresh air for the manufacturing industry in improving the quality of the company's internal and external communications. However, for the print media industry, the presence of communication technology is not only an opportunity but also a challenge to survive in the digital era (Prihanto 2018). One of the newspaper industries affected by the digital era is PT XYZ.

In the business process in the newspaper industry, there are suppliers of raw materials/suppliers (paper: PT. Adiprima Suraprinta, ink: PT. Cemani Toka, plate: CV. Nagasaki), PT. Solo Graphic Utama for the printing process, PT XYZ for newspaper content creation, Agent for distributing newspapers to customers, regular customers or dropout customers. There are also several flows in the business process picture, namely the flow of money, the flow of information and data, and the flow of materials.

In A'yun et al (2021) research entitled Selection of the Forecasting Method for the Number of Newspaper Requests with the Lowest Error Rate, they succeeded in determining the most suitable method used to carry out the number of newspaper requests in Surakarta, namely the Trend Line Analysis method with the lowest error rate compared to several other methods, namely Double Exponential Smoothing, Two Months Moving Average, and ARIMA. The data used is demand data in April 2017. Based on the explanation above, in this study we use data assumptions in 2021 with several assumptions, namely a decrease in demand by 6% per month from 2017, an increase in demand by 6% per month from 2017, and seasonal demand data in 2021 using the method proposed by the previous paper, namely Trend Line Analysis.

Trend line analysis is used to predict future events or conditions. While planning is an effort to formulate actions for the future. Therefore, trend lines are used in planning because basically planning is also related to the future. In this study, there is a development from previous research, namely after selecting the best method of trend line analysis, we tested the trend line analysis method on the data of decreasing demand, increasing demand, and seasonal data.

Permatasari, et al (2018) raised the problem of frequent inaccuracies of supply with demand which means that many newspapers are returned and then generate alternative solutions by predicting newspaper demand as accurately as possible to minimize the number of returns, to avoid missed sales and to contain excess supply by ARIMA method. The problem raised by A'yun, et al (2021) is that it is necessary to determine the method of forecasting the number of newspaper requests that has the smallest error rate so that it can help companies reduce losses due to newspaper returns so as to produce alternative solutions by calculating demand forecasting using several methods, including trend line analysis. , double exponential smoothing, and two months moving average. In addition, this study also compares the forecasting results with previous studies using the ARIMA method.

Henderi, et al (2019) the aim of this research is to discuss about conceptual and conceptual aspects about periodic data, calculation of straight line trends through free method, half moving average, half average and least number of squares, nonlinear trend calculation which is trend parabola and exponential trends, calculations for changing trend equations into quarterly and monthly trends, calculations for changing trend equations into average trends, calculating seasonal variation values through simple average methods, ratio to trend, ratio of moving averages and relative berangkai, and calculation of cyclic variation values for annual and quarterly data.

2. Methods

Forecasting method is used to solve the problems encountered. This research uses trend analysis methods to forecast demand for company newspaper. The trend line analysis method is a forecasting method that condition in the movement of the data has a pattern that continues to increase or continues to decrease with a relatively repeated pattern (Richard & Rahardjo, 2019). The data used is when demand conditions increase, decrease, and seasonal. The three conditions will be compared with the lowest MAPE value, so that the appropriate conditions are obtained for trend analysis using the method. Figure 1 shows the data processing flow chart.
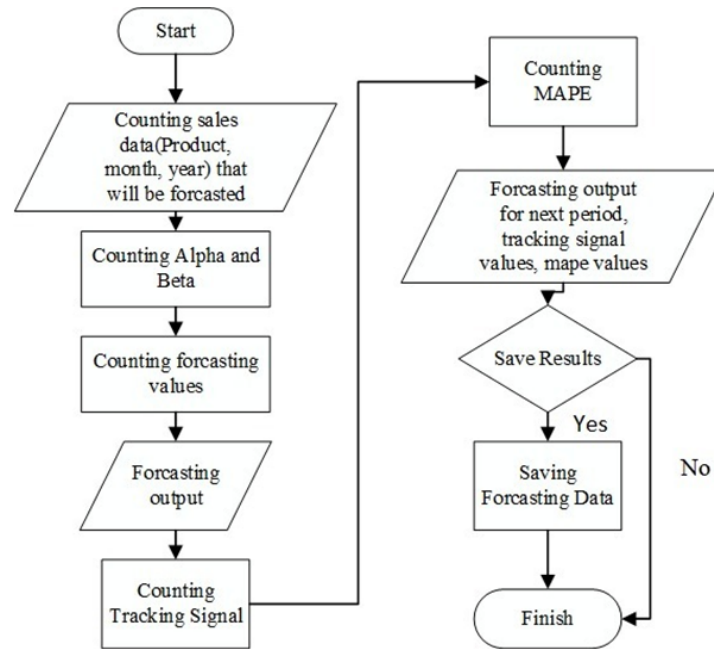
Figure 1. Data processing flowchart

Forecasting formula with trend line analysis method is as follows:

$$F_t = a + b.t \tag{1}$$
$$a = \bar{A} - b.\bar{t} \tag{2}$$
$$b = \left(\frac{\sum t\, A - n.\bar{t}.\bar{A}}{\sum t^2 - n.(\bar{t})^2} \right) \tag{3}$$

Description:
F_t = Forecasting values
a = Intercept
$\bar{A}$ = Average Demand per period
A = Real Demand
b = Slope
t = Time Index

MAPE is used to find the mean percentage of absolute bias (error rate) (Makridakis et al, 1982). MAPE is calculated as the mean of the absolute difference between the predicted and actual values, expressed as a percentage of the actual values (Savira et al, 2015). The Mean Absolute Percentage Error (MAPE) formula is as follows:

$$MAPE = \left(\frac{100}{n} \right) \sum \left| A_t - \frac{F_t}{A_t} \right| \tag{4}$$

Description:
At = Actual Demand on t-period
Ft = Demand Forecast on t-period
n = Total of forecasted period

Tracking Signal is used for model validation (Gaspersz, 1998). A positive tracking signal indicates that the actual demand value is greater than the forecast, while a negative indicates that the actual demand value is less than the forecast. A good tracking signal has the same positive error as the negative error, so the tracking signal is close to zero (Heizer & Render, 2006). If the tracking signal control chart does not exceed the upper and lower limits, namely +4 and -4, then it can be forecasted the number of product requests (Febrina et al, 2013). Signal Tracking Formula as follows:

$$Tracking\ Signal = \frac{RSFE}{MAD} = \frac{\sum (actual - forecast)}{MAD} \tag{5}$$
$$MAD = \frac{\sum (Y_i - \bar{Y}_i)}{n} \tag{6}$$

Description:

Y_i = Data on period-i
n = Total of forecasted period

3. Results and Discussion

3.1 Data Collection

The data used is the assumption of newspaper sales from August 2020 to October 2021 with three conditions, namely a downward trend of 6% every month, an increase of 6% every month, and seasonal. The following is the pattern of sales data for August 2020-October 2021 with three conditions, namely a down, up, and seasonal trend which is assumed from the A'yun 2021 data. Figure 2 assumes an increasing trend of 6% every month. Figure 3 assumes a downward trend of 6% each month. And figure 4 assumes an increase and a decrease (seasonal) every month.
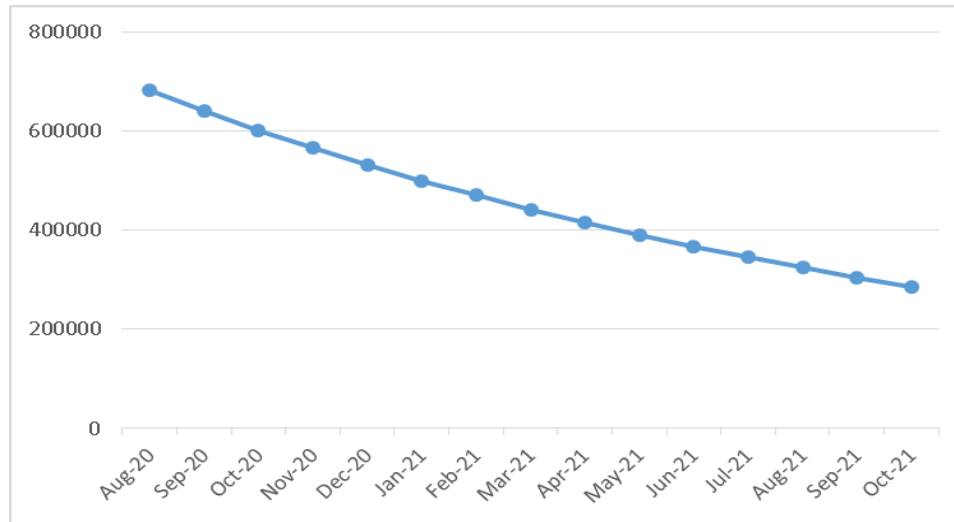

Figure 2. Newspaper Demand Data Chart When the Trend is down
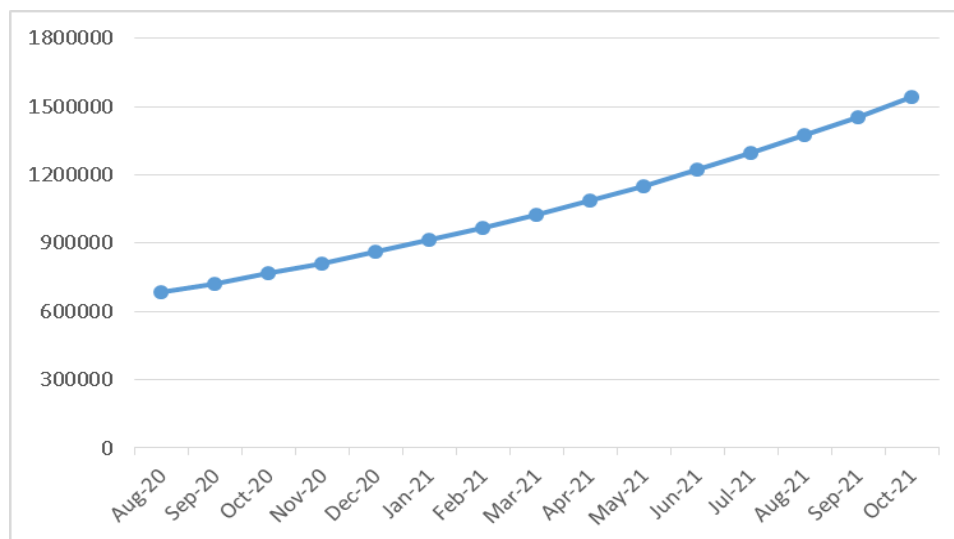(Source: A'yun, 2021 with the additional assumption of an increase of 6% every month)

Figure 3. Newspaper Demand Data Chart When the Trend is up
(Source: A'yun, 2021 with the additional assumption of a decrease of 6% every month)
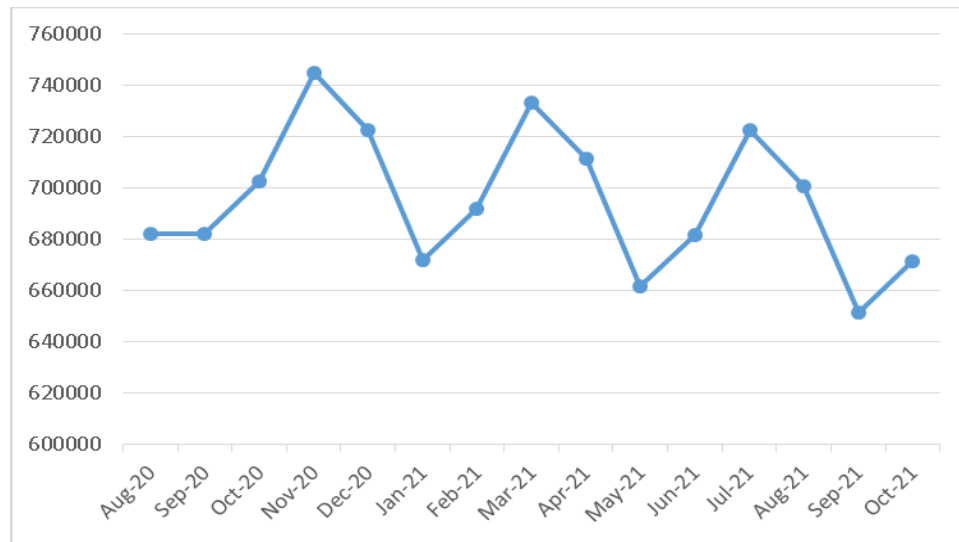
Figure 4. Newspaper Demand Data Graph When the Trend is Seasonal
(Source: A'yun, 2021 with the additional assumption of increasing and decreasing (seasonal) every month)

3.2   Result

The demand data is then processed using the trend line analysis method. The results of the demand forecasting with the three conditions will be compared to find out under what conditions the demand forecast is accurate. Forecasting with trend line analysis is done by modeling existing historical data into a linear equation. The linear equation is determined by calculating the values of a and b using equations (2) and (3). Linear equations can be formed using equation (1). Then, forecasting in the next period can be calculated using the linear equation. Linear equations are solved using Microsoft Excel software.

Table 1. Forecasting Results and Error Rate Trend Line Analysis Method When the Trend is down

| Period (t)	Actual Demand (A)	Demand Forecast (D)	Tracking Signal	Absolute Percent Error (%)
Aug 20	682177	654074	2.27	4.12
Sept 20	641246	626113	1.22	2.36
Oct 20	602772	598153	0.37	0.77
Nov 20	566605	570193	-0.29	0.63
Dec 20	532609	542233	-0.78	1.81
Jan 21	500652	514273	-1.10	2.72
Feb 21	470613	486313	-1.27	3.34
Mar 21	442376	458353	-1.29	3.61
Apr 21	415834	430393	-1.18	3.50
Mei 21	390884	402433	-0.93	2.95
Jun 21	367431	374473	-0.57	1.92
Jul 21	345385	345613	-0.09	0.33
Aug 21	324662	318553	0.49	1.88
Sept 21	305182	290593	1.18	4.78
Oct 21	286871	262633	1.96	8.45
Nov 21		234673		
Dec 21		206713		
MAPE				**2.88**
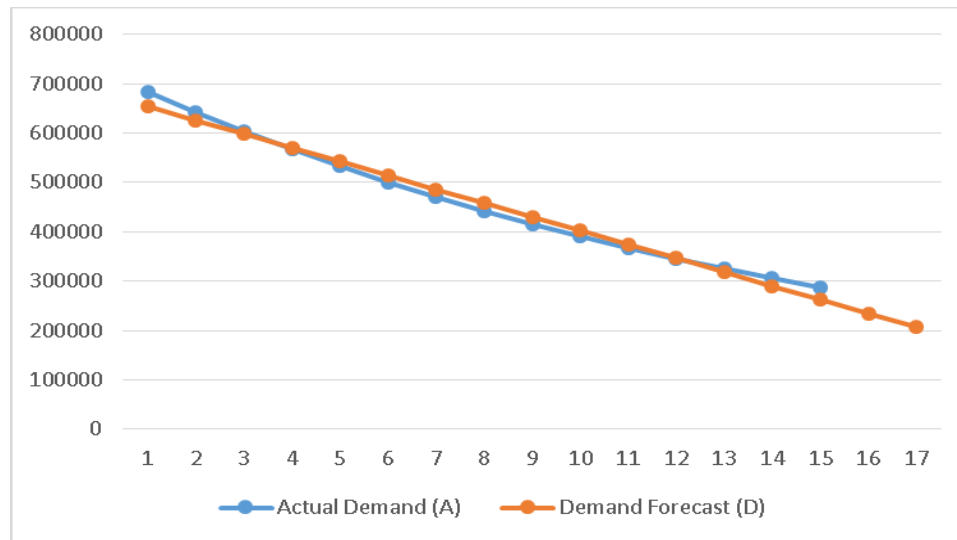
Figure 5. Actual Comparison Graph and Forecasting Trend Line Analysis Method When the Trend is down

The following is an example of the calculation:
Known:
$\sum tA = 47173597$
$\sum t^2 = 1240$
$\bar{A} = 458353.4$
$\bar{t} = 8$
$n = 15$
Calculation:
$$b = \frac{\sum tA - n\bar{t}\bar{A}}{\sum t^2 - n\bar{t}^2}$$
$$b = \frac{47173597 - 15x8x458353.4}{1240 - 15x8^2}$$
$n = -27960$
$a = \bar{A} - b\bar{t}$
$a = 458353.4 - (-27960)x8$
$a = 682033.5$

Based on these calculations, the equation:
$Ft = a + bt$
$Ft = 682033.5 - 27960t$
Where:
Ft = forecasting result for period t

Example:
$Ft1 = 682033.5 - 27960(1) = 654073.5$
$Ft2 = 682033.5 - 27960(2) = 626113.5$
$Ft2 = 682033.5 - 27960(3) = 598153.5$

Forecasting results using the trend line analysis method when the trend is down in Table 1 shows that the demand in November 2021 was 234673 newspapers and in December 2021 there were 206713 newspapers. Forecasting results with this condition have an error rate (MAPE) of 2.88%. The tracking signal value shows the level of data habit, where if the tracking signal value is between -4 and 4 then the data is not biased. However, if the opposite is true, then the data is said to be biased. In forecasting with the trend line analysis method when the trend is down, the value of the last tracking signal is between -4 and 4 so that the forecasting results are said to be unbiased. Based on the graph in Figure 5, it can be seen that the actual data distribution is not far from the forecasting curve. This shows that the error

rate for forecasting using the trend line analysis method when the trend is down is quite small, because the data are not spread far from the curve.

Table 2. Forecasting Results and Error Rate Trend Line Analysis Method When the Trend is up

| Period (t)	Actual Demand (A)	Demand Forecast (D)	Tracking Signal	Absolute Percent Error (%)
Aug 20	682177	632212.6	1.97	7.32
Sept 20	641246	693118.7	1.18	4.15
Oct 20	602772	754024.8	0.49	1.63
Nov 20	566605	814930.9	-0.10	0.30
Dec 20	532609	875837.1	-0.57	1.70
Jan 21	500652	936743.2	-0.94	2.61
Feb 21	470613	997649.3	-1.18	3.10
Mar 21	442376	1058555	-1.29	3.20
Apr 21	415834	1119462	-1.27	2.96
Mei 21	390884	1180368	-1.10	2.42
Jun 21	367431	1241274	-0.77	1.60
Jul 21	345385	1302180	-0.28	0.56
Aug 21	324662	1363086	0.38	0.70
Sept 21	305182	1423992	1.22	2.13
Oct 21	286871	1484898	2.26	3.72
Nov 21		1545804		
Dec 21		1606711		
MAPE				**2.54**
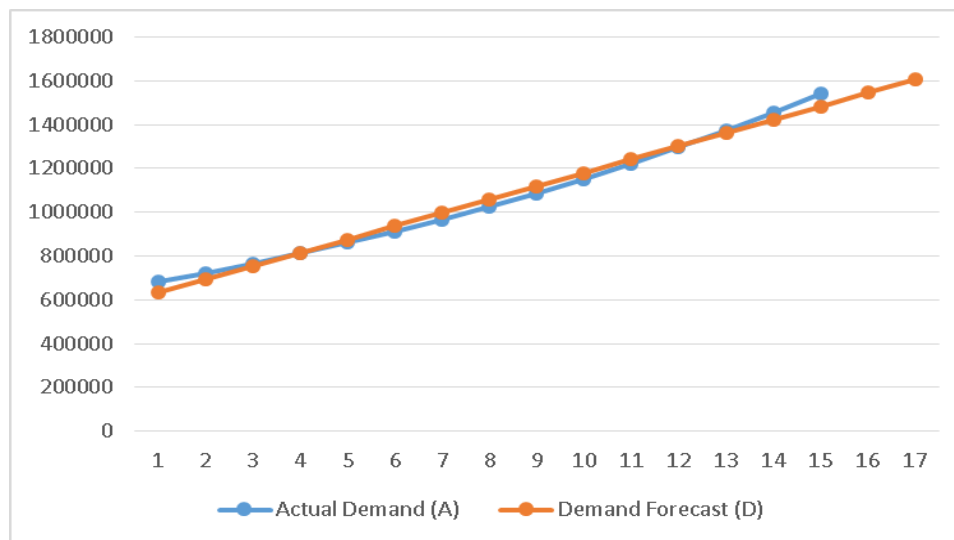
Figure 6. Actual Comparison Graph and Forecasting Trend Line Analysis Method When the Trend is down

Forecasting results using the trend line analysis method when the trend is up in Table 2 shows that the demand in November 2021 was 1545804 newspapers and in December 2021 there were 1606711 newspapers. Forecasting results with this condition have an error rate (MAPE) of 2.54%. In forecasting using the trend line analysis method, when the trend is up, the last tracking signal value is between -4 and 4, so the forecasting results are said to be unbiased. Based on the graph in Figure 6, it can be seen that the actual data distribution is not far from the forecasting curve. This

shows that the error rate for forecasting using the trend line analysis method when the trend is up is quite small, because the data are not spread far from the curve.

Table 3. Forecasting Results and Error Rate Trend Line Analysis Method When the Trend is Seasonal

| Period (t)	Actual Demand (A)	Demand Forecast (D)	Tracking Signal	Absolute Percent Error (%)
Aug 20	682177	707540	-1.13	3.72
Sept 20	641246	705825	-1.06	3.47
Oct 20	602772	704111	-0.07	0.21
Nov 20	566605	702396	1.90	5.69
Dec 20	532609	700681	0.97	3.01
Jan 21	500652	698966	-1.21	4.03
Feb 21	470613	697251	-0.23	0.75
Mar 21	442376	695537	1.70	5.18
Apr 21	415834	693822	0.79	2.49
Mei 21	390884	692107	-1.36	4.59
Jun 21	367431	690392	-0.39	1.29
Jul 21	345385	688677	1.51	4.68
Aug 21	324662	686693	0.62	1.98
Sept 21	305182	685248	-1.50	5.14
Oct 21	286871	683533	-0.55	1.82
Nov 21		681818		
Dec 21		680103		
MAPE				3.20
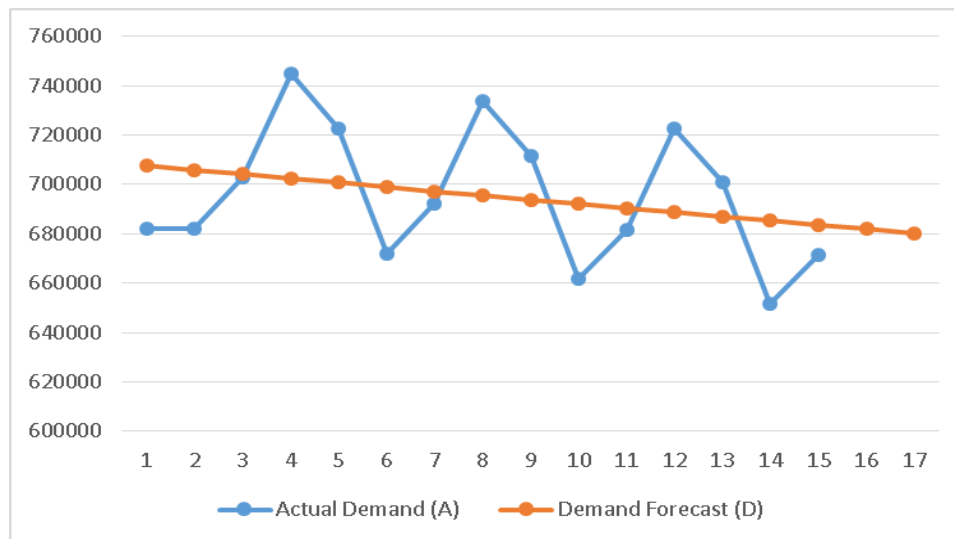
Figure 7. Actual Comparison Graph and Forecasting Trend Line Analysis Method When the Trend is Seasonal

Forecasting results using the trend line analysis method when there is a seasonal trend in Table 3 shows that the demand in November 2021 was 681818 newspapers and in December 2021 there were 680103 newspapers. Forecasting results with this condition have an error rate (MAPE) of 3.20%. In forecasting using the trend line analysis method when the seasonal trend of the last tracking signal value is between -4 and 4 so that the forecasting results are said to be unbiased. Based on the graph in Figure 7, it can be seen that there is a significant difference between the results of forecasting using the trend line analysis method when the trend is seasonal and the actual data in periods 4, 8, and 12.

Based on previous research conducted by A'yun et al (2021), they succeeded in determining the most suitable method used to perform the number of requests for newspapers in Surakarta, namely the Trend Line Analysis Method with the lowest error rate compared to several other methods, namely Double Exponential Smoothing, Two-Month Moving Average, and ARIMA. For this reason, this research is a development of research that has been carried out by A'yun et al (2021) by forecasting with trend line analysis in three conditions, namely when demand is up, down, and seasonal, so that the appropriate conditions are obtained for trend analysis using the method. In previous research, only forecast for 1 month, while this research predicts demand for the next 2 months. Based on previous research that has been carried out on the same method but with a normal trend, the calculation of forecasting the number of newspaper requests using the trend line analysis method shows that demand in April 2017 was 590446 copies with an error rate (MAPE) of 2.94%.

Table 4. Comparison of Forecasting Results with Trend Line Analysis Methods in Several Conditions

Forecasting Method	Forecasting Results	MAPE (%)	Tracking Signal	Description
Trend Line Analysis When The Trend is Down	234673 234673	2.88	1.91	Unblased
Trend Line Analysis When The Trend is Up	1545804 1545804	2.54	2.31	Unblased
Trend Line Analysis When The Trend is Seasonal	681818 681818	3.20	-0.45	Unblased
Trend Line Analysis When without Trend (A'yun, 2021)	590446	2.94	0	Unblased

Based on the comparison results in Table 4, it can be seen that the forecasting method with the smallest error rate (MAPE) is the trend line analysis method with an uptrend condition which has an error rate of 2.54%. Therefore, the forecasting method using the trend line analysis method has the smallest error rate when the demand trend is up. The selection of the right forecasting method according to data trend conditions can reduce the rate of return or newspaper returns to the company and can reduce company losses. From this comparison, it can also be seen that trend line analysis, when the trend is up, produces tracking signals that are smaller than previous studies. This means that it has a smaller forecasting error rate. So that this study provides better results than previous studies.

4. Conclusion

This study describes the condition of forecasting demand for newspapers using the trend line analysis method. Several data trend conditions are compared to what data conditions the trend line analysis method chooses an accurate forecast. From the analysis that has been carried out, the trend line analysis method for the downtrend has an error rate of 5.41%, the trend line analysis method for the downtrend has an error rate of 4.56%, and the trend line analysis method for seasonal trends has an error rate of 5.12%. It can be seen that the trend line method analysis is most suitable to be used for forecasting in condition if the trend is up/increasing. The results of this study can be used by companies to carry out production planning so that later the rate of return or newspaper returns can be lower, and the company can reduce losses that occur.

The advantage of the trend line analysis method is that it is very easy to understand and use in forecasting calculations. The disadvantage of this method is that it requires a lot of data from the past. So the trend line analysis method is used by traders over a long period, such as weekly or monthly.

The development of this research can be done by comparing the trend line analysis method in various conditions with other methods such as the censored regression method. The use of censored regression models helps to devise a policy with a better statistical underpinning. A censored regression allows a formal assessment of the impact of a specific service policy in terms of service level and the trade-off with respect to excess supply it generates. At the same time, it allows a more formal identification of the influences that are relevant in the forecasting system.

References

A'yun, A. H. Q., Sutopo, W., Ardian, H., Nunuh, M. K., Immanuella, S., & Yuniaristanto, Y, Selection of Forecasting Method Number of Newspaper Requests with the Lowest Error Rate. *Matrik*, *21*(2), 91. https://doi.org/10.30587/matrik.v21i2.1325, 2021.

Aliudin, E. R. and Arisanty, M, Hai Magazine's Digital Transformation in an Effort to Maintain Brand Existence. *Widyakala: Journal of Pembangunan Jaya University*, *5*(2), 77-96, 2018.

Febrina, M., Arina, F., and Ekawati, R., Peramalan jumlah permintaan produksi menggunakan metode jaringan syaraf tiruan (JST) backpropagation, *J. Tek. Ind.* vol. 1, no. 2, pp. 174– 179, 2013.

Gaspersz, V., Production Planning and Inventory Control. Jakarta: PT. Sun, 1998.

Heizer, J and Render, B., Operations Management, Edition 9 Trans. Chriswan Sungkono. Jakarta: Four Salemba, 2006.

Henderi, Zuliana, S. R., and Pradana, R. A., Periodic Data Analysis and Forecasting as an Overview of Future Management Economics, ATM, Vol 1, No. 3, e-ISSN: 2622-6804 p-ISSN: 2622-6812 doi:10.33050/atm.v3i1.846, 2019.

M. Febrina, F. Arina, and R. Ekawati., Forecasting the number of production requests using the backpropagation artificial neural network (ANN) method. *Jurnal Teknik Industri*, 1 (2), 174–179, 2013.

Makridakis, S., Andersen, A., Carbone R., Fildes, R., Hibon, M., Lewandowski, R., Newton, J., and Winkler, R., The Accuracy of Extrapolation (Time Series) Methods: Results of a Forecasting Competition. *Journal Forecast*, vol. 1, no. 2, pp. 111–153, doi: 10.1002/for.3980010202, 1982.

Permatasari, C. I., Sutopo, W., and Hisjam, M., Sales Forecasting Newspaper with ARIMA: A Case Study, *AIP Conference Proceedings* 1931, 03001*,* https://doi.org/10.1063/1.5024076, 2018.

Prihanto, J. N, Digital Transformation of Print Media in Indonesia: A Study on Administrative and Factual Verified Print Media Industry 2017. *Ultima Management: Jurnal Ilmu Manajemen*, *10*(1), 26-43, 2018.

Richard and Rahardjo. J., Improvement of Paper Raw Material Management With MRP I At PT. X. *Jurnal Titra*, vol. 7, no. 2, pp. 129–136, 2019.

Savira., Forecasting Analysis of Sales of Generic Drugs with Logo (OGB) at PT. Indonesia Farma, *Journal of Chemical Information and Modelin*g, vol. 53, no. 1, pp. 1–13, 2015.

Biographies

Hani Aninda Intan P is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. Her research interests are in the supply chain, logistics, business, techno economy, and sustainability.

Muhammad Raihan Syaifudin is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. Her research interests are in the supply chain, logistics, business, techno economy, and sustainability.

Safira Nariswari is an undergraduate student of the Industrial Engineering Department of Universitas Sebelas Maret, Surakarta, Indonesia. Her research interests are in the supply chain, logistics, business, techno economy, and sustainability.

Nida An Khofiyah is a lecturer of Industrial Engineering Department, Pelita Bangsa University. She has graduated in Undergraduate and Master Program of Industrial Engineering Department, Universitas Sebelas Maret, Surakarta, Indonesia. Research interests are related to techno-economics, logistics, commercialization technology, and drone technology. She has published research five papers in 2021 about commercialization and supply chain management. She has published 11 articles Scopus indexed.

Wahyudi Sutopo is a professor in industrial engineering and coordinator for the research group of industrial engineering and techno-economy (RG-RITE) of Faculty Engineering, Universitas Sebelas Maret (UNS), Indonesia. He earned his Ph.D. in Industrial Engineering & Management from Institut Teknologi Bandung in 2011. He is also a researcher for the university center of excellence for electrical energy storage technology (UCE-EEST). He has done projects with Indonesia endowment fund for education (LPDP), sustainable higher education research alliances (SHERA), MIT-Indonesia research alliance (MIRA), PT Pertamina (Persero), PT Toyota Motor Manufacturing Indonesia, and various other companies. His research interests include logistics & supply chain management, engineering economy, cost analysis & estimation, and technology commercialization. He is a member of the board

of industrial engineering chapter - the institute of Indonesian engineers (BKTI-PII), Indonesian Supply Chain & Logistics Institute (ISLI), Society of Industrial Engineering, and Operations Management (IEOM), and Institute of Industrial & Systems Engineers (IISE).

Yuniaristanto is a lecturer of Department of Industrial Engineering, Universitas Sebelas Maret (UNS). He obtained his Master of Engineering from Institut Teknologi Bandung and Bachelor of Engineering in Industrial Engineering from Institut Teknologi Sepuluh November. He is part of the Industrial Engineering and Techno -Economy (RITE) Research Group. His research interests are Logistics & Supply Chain Management, and Production/Operations Management.