Management and Production Engineering Review
Volume 15 • Number 1 • March 2024 • pp. 90–99
DOI: 10.24425/mper.2024.149992

Production Forecasting of Indonesian Traditional Medicine (Jamu) Based on Information System by Using Single Exponential Smoothing Method

Rika YUNITARINI[1], Muhamad Afif EFFINDI[2]

[1] *Trunojoyo University, Department of Informatics Engineering, Indonesia*
[2] *Trunojoyo University, Department of Informatics Education, Indonesia*

Received: 15 September 2023
Accepted: 24 December 2023

Abstract
Indonesia is widely known as a country with rich biodiversity. Medicinal plants that thrive in Indonesia are utilized as traditional medicine locally known as "jamu". One of the islands famous for jamu production is Madura Island. As a well-known jamu producer, Madura Island are facing problems related to jamu production. Procurement of medicinal plants is not well controlled. There are no reports of spices procurement and production. When there is an increase in demand or sale of certain jamu, the stock of jamu is commonly inadequate/insufficient This may result in order cancellation. The solution to this problem is to create a production forecasting information system by using single exponential smoothing. The data used is a weekly report on the number of sales of 3 types of jamu from August to October 2024. Mean Absolute Percentage Error (MAPE) testing using an alpha value of 0.1 to 0.9 resulted in "high" accuracy and the forecasted values were close to the actual data values.

Keywords
Forecasting, Indonesian Traditional Medicine, Information System, Jamu, Production, Single Exponential Smoothing.

Introduction

Indonesia has a rich diversity of medicinal plants. More than 1000 plant species can be used as raw materials for making medicine (Karamina et al., 2020). The cultivation of medicinal plants in Indonesia has been growing, positioning Indonesia as the second largest producer after Brazil (Margarethy, et al., 2019; Wahidah, 2013). Plants are not only used as cooking spices, food ingredients and decoration, they are also beneficial for maintaining and increasing the body's immunity (La Fua, 2020; Pertiwi et al., 2020). Various species of medicinal plants as the basic ingredients of traditional medicine are widely grown in Indonesia, especially plants used as herbs and spices in traditional Javanese medicinal practices (Sumarni et al., 2019). Traditional Indonesian herbal medicine that has been practiced for centuries in Indonesian society is still very popular for maintaining health and treating diseases, because it is safer compared to chemical materials. This traditional medicine is generally known as jamu (Woerdenbag et al, 2014). Jamu is a complex mixture of herbs widely used throughout Indonesia, especially in Java and Madura Island (Widyawaruyanti et al., 2007). Herbal medicine is a concoction made from parts of plants such as roots, bark, leaves, and fruit which has efficacious properties. Herbal medicine also uses ingredients from animal organs, such as goat bile and others. The composition of herbal medicine made in this activity includes sambiloto, ginger, cat's whisker, lempuyang, and cinnamon (Abidin and Indriani, 2024).

Herbal medicine is made from spices such as ginger which is useful for maintaining the immune system. This makes the body fit and can also prevent and kill harmful bacteria in the body. Therefore, the immune system will increase. Beside ginger, turmeric is also used for making traditional medicine. Turmeric is an antioxidant, antitumor, and anticancer. The compounds of turmeric, which are curcuminoids and essential oils, play an important role in the utilization of the material. Antioxidants are compounds that can

Corresponding author: *Rika Yunitarini – Department of informatics engineering, Trunojoyo University, Indonesia 69162, phone: +62 888-3323-023, e-mail: rika_yunitarini@yahoo.com*

counteract free radical compounds. Curcuminoid compounds in turmeric rhizome have cytotoxic properties that can inhibit the growth of cancer cells as well as reduce and eliminate odor, itchy, and reduce the size of cancerous wounds. Therefore, turmeric can be used as an anti-inflammatory which is useful in cancer and tumor treatment therapies. Moreover, cinnamon offers notable benefits due to its high antioxidant content, which effectively bolsters the immune system. This property aids in preventing the body from succumbing to various disease-causing bacteria, germs, and viruses. Additionally, lemongrass leaves are advantageous for reducing fever and eliminating harmful substances from the body (Fuji, 2020). Jamu, a traditional herbal medicine from Indonesia, is characterized by the use of natural ingredients and traditional production methods. It is produced from various plants known for their health benefits. The production process of jamu involves several steps, including raw material selection, sorting, grating, scraping, crushing, mixing, and cooking, followed by boiling the plant materials (Woerdenbag and Kayser, 2014). Practitioners of traditional medicine typically acquire their knowledge through familial inheritance or experiential training. As traditional medicine is rooted in local wisdom, its practices vary across different cultures (Liem and Rahmawati, 2017). Once the production steps are completed, jamu is packaged using plastics for widespread use by the Indonesian population to maintain health and combat various illnesses. The herbal industry is experiencing growth domestically and internationally, with herbal companies emerging in various regions, introducing new medicinal herbs beneficial not only to Indonesia but also to other countries, particularly in the ASEAN region (Hidayat, 2018). Jamu serves as an alternative to conventional medicine due to its plant-based origins. Herbal medicine ingredients contain essential components such as immunomodulators and antioxidants, supporting the body's immune system and overall health (Ikawati, 2018). The Indonesian Ministry of Industry reports that herbal medicine has penetrated export markets, with sales reaching Rp. 15 trillion in 2014, involving numerous small-scale industries (Kemenperin, 2015). The use of traditional medicine has ancient roots, spanning thousands of years (Arifin et al., 2016).

Madura, situated on the north of Java, Indonesia, is primarily inhabited by its indigenous population (Rohaniyah, 2016), who uphold their cultural heritage, shaped by ecological factors and local community characteristics (Dharmawan and Aji, 2018). As one of Indonesia's ethnic groups, the Madurese maintain the traditional use of medicinal herbs (Purwanti et al., 2020), contributing to the island's rich knowledge of traditional medicine. Consequently, herbal medicine is widely practiced on Madura Island (Satriyati, 2017). Historically, Madura has been renowned for its diverse array of medicinal plants, catering to various segments of society with products tailored for women's health, couples, men, married couples, and specific ailments like empot-empot, sari rapet, and strong medicine (Royhan and Rum, 2022). However, the traditional herbal medicine industry, particularly Jamu, faces challenges in maintaining its relevance amidst modern lifestyles. Jamu businesses primarily offer physical products, thereby emphasizing the consumption value for customers (Amalia and Aprianingsih, 2017). Several issues hinder traditional herbal medicine production. Due to the unique characteristics of ingredients and production methods, there is a lack of control over procuring raw materials such as ginger and turmeric. Insufficient monitoring of spice requirements and production outcomes leads to shortages when demand spikes, resulting in order cancellations or delays until raw materials become available again. Procuring medicinal herbs can take anywhere from a day to several weeks, and an increase in customers further disrupts the procurement process, potentially causing losses for Madura herbal medicine businesses.

To address the current challenges, the development of a production forecasting information system is proposed. This system aims to predict future herbal medicine orders, enabling proactive measures to mitigate potential issues, such as staffing adjustments and accurate spice procurement. Weekly sales data from August 2024 to October 2024 are utilized for forecasting, facilitating better control over product stock levels to minimize shortages or excess inventory. Accurate sales predictions ensure timely fulfillment of consumer demand and maintain supplier relationships, thus preventing revenue loss or stockouts that could drive consumers to competitors (Gustriansyah et al., 2019). Effective forecasting requires analyzing data patterns to select the appropriate method. The Single Exponential Smoothing method is suitable for stable or minimally changing data patterns, offering short-term forecasting capabilities aligning with weekly sales predictions (Lusiana and Yuliarty, 2020). This method involves continuously revising forecasts based on recent information to adapt to evolving sales trends (de Oliveira and Oliveira, 2018).This study focuses on developing an information system to forecast the production volume of traditional herbal medicine. The system employs the Single Exponential Smoothing method to aid management in future business decision-making. Additionally, the research aims to address current challenges by leveraging predicted herbal medicine order outcomes.

Literature review

Throughout history, human health concerns have spurred the utilization of plants and animals as sources of traditional medicine, evident in depictions found in temples, books, and inscriptions (Dar et al., 2017). Indigenous knowledge of medicinal plants has long been integral to the cultures of China, India, Brazil, Ethiopia, and Indonesia (Pan et al., 2013). Indonesia, boasting the world's second-largest biodiversity, possesses a wealth of indigenous medicinal plants. Consequently, traditional herbal medicines, known as jamu, are widely used by the Indonesian populace, particularly in rural areas (Woerdenbag and Kayser, 2014). Originally a term from the Javanese tribal language, "jamu" signifies traditional medicine derived from plants, now adopted into Bahasa Indonesia with the same meaning (Riswan and Sangat-Roemantyo, 2002). Today, jamu production is scaling up industrially. Recognizing the need for extensive research to ensure the safety and efficacy of traditional jamu preparations, the Indonesian government, industry, and academia are actively involved in furthering its development (Woerdenbag and Kayser, 2014). The tradition of consuming traditional medicine remains widespread in several Asian countries, Latin America, and Africa, including Indonesia and India (Prabhakaran et al., 2016). The enduring efficacy and safety of various medicinal plants, rooted in indigenous knowledge, continue to be validated by empirical evidence (Pan et al., 2013; Rodrigues and Barnes, 2013). In Indonesia, a wide array of medicinal plants, especially empon-empon or herbs and spices used in traditional Javanese medicine, are cultivated (Sumarni et al., 2019). The demand for information regarding the Indonesian traditional herbal drink, jamu, has surged in recent years due to its increasing popularity as an economical alternative treatment option. Expertise in jamu is essential for providing guidance on the types of jamu to consume, brewing methods, and sourcing (Susanto et al., 2019). In the field of informatics, research on Traditional Medicine encompasses various areas, including clinical data warehousing, computational intelligence, bioinformatics, and informatics standards (Zhao et al., 2018; Walonoski et al., 2018). Spiritual care and facilitating Islamic obligations are the primary focus of informatics in Traditional Arabic and Islamic Medicine (Chatfield et al., 2018). Knowledge about the composition and usage of herbs in jamu is crucial for safe medicinal use, enabling the avoidance of adverse interactions between plants. This knowledge also facilitates the discovery of new herbal combinations for treating diseases and must be disseminated throughout society to maximize its benefits (Gunawan and Mustofa, 2017). Semantic web technology, employing ontology, serves as a valuable tool for organizing and sharing information about jamu, enabling users to access and understand complex relationships between jamu formulations and their properties (Gunawan and Mustofa, 2017).

Scientific analysis of jamu involves statistical models such as Biplot, Partial Least Square Discriminant Analysis (PLS-DA), and Bootstrapping to identify correlations between plants, jamu formulations, and their properties (Afendi et al., 2013). These methods aid in classifying the efficacy of jamu formulas, albeit with varying degrees of accuracy. While ontology development may not directly measure accuracy, it facilitates user comprehension of the relationship between jamu formulations and their benefits.

Yang et al. (2013) conducted research on Oriental Herbs, particularly traditional Korean medicine from Bangyakhappyeon, investigating the relationship between symptoms and herbal materials using association rule techniques. This study utilized support value, confidence, and lift to establish association rules, with a minimum confidence level set at 20%. The utilization of medicinal plants has seen various approaches, notably through classification and association techniques.

However, there exists a significant informatics gap in the field of Indonesian Traditional Medicine, with no literature found on the application of informatics in this domain. Therefore, the author proposes a system capable of collecting relevant information and organizing it into knowledge. This knowledge can then be accessed by the public to gain insights into treating specific diseases. To achieve this, a standard model is required to represent all information pertaining to jamu.

Materials & Methods

This research employed quantitative method with the following stages:

Data Collection

The collection of data is the most important stage in the research. The data in this study is time series data, data collected within a certain time based on the time at equal intervals (every week). The data consists of traditional herbal medicine purchasing data from August 2024 to October 2024.

Data Analysis

Analysis of time series data is a statistical procedure on time series data applied to predict the state which will appear into the decision making process. Time series data is usually analyzed to find patterns of growth or changes in the past that can be used to predict future patterns in line with the needs of business operations. Time series data in this study is a summary of all the sales transaction data from August to October 2024 shown as a graph with horizontal data pattern in Figures 1, 2, 3.

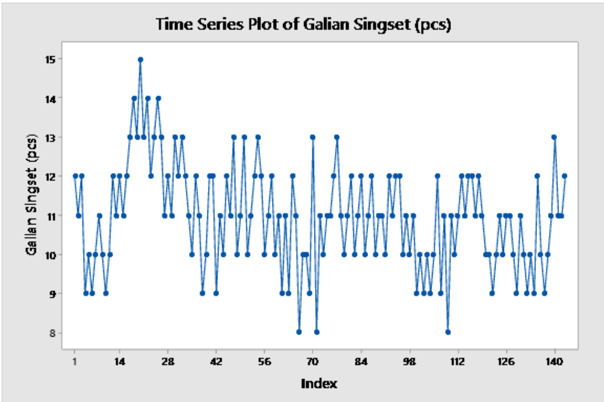

Fig. 1. Time series plot of jamu galian singset

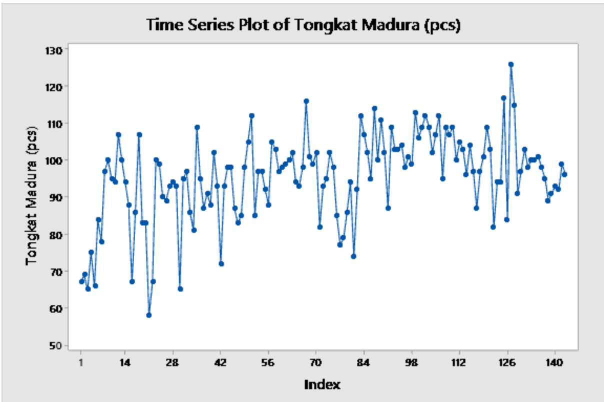

Fig. 2. Time series plot of jamu tongkat madura

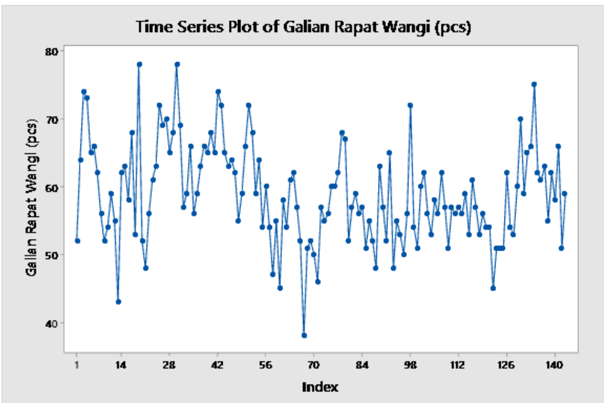

Fig. 3. Time series plot of jamu galian rapet wangi

As Fig. 1 indicates, the average and variance are almost constant. In the data pattern above, there is an increase. Then, it returns to constant against the average. The highest score is 15 and the lowest score is 8. While the average value is 10.95. So it can be seen that the movement of values in the data above is around the average value.

As Fig. 2 shows the pattern is constant even though it has changed. The changes are not too significant. The data also experiences a random fluctuating trend. So, the data above can still be said to be a horizontal data pattern.

As Fig. 3 indicates, the data increased and decreased randomly. The average and variance data are constant even though at the beginning of the period, there is an increase in the average and variance. However, the data movement can be considered constant.

Implement single exponential smoothing method

This research employed the single exponential smoothing method, suitable for stable or stationary data. Analysis of the time series plot indicates that the purchasing data of jamu remains relatively stable. This method is well-suited for long-term and medium-term forecasting, particularly at the operational level of a company, where the production of traditional herbal medicine (jamu) occurs. The main advantage of exponential smoothing lies in its simplicity, making it the most widely used forecasting technique due to its minimal computational requirements (Nazim and Afthanorhan, 2014). This method is typically applied when the data pattern is nearly horizontal (Ostertagová et al., 2011). In single exponential smoothing, newer data is given greater weight than older data, resulting in an equation formulation represented as Equation (1) (Makridakis et al., 1999).

$$F_{t+1} = F_t + \left(\frac{X_t}{N} - \frac{X_{t-N}}{N}\right) \tag{1}$$

F_{t+1}: Next period forecasting
F_t: t period forecasting
X_t: t actual data
X_{t-N}: Previous actual data
N: Amount of actual data

Single exponential algoritm as a parameter of the process of running a coherent system in solving problems is described in Figure 4 (Anggoro and Wulandari, 2019).

Figure 4 presents the forecasting flow using the Single Exponential Smoothing method. The explanation of the algorithm above is as follows:

1. Forecasting using the Single Exponential Smoothing method begins by inputting the value of each type of data for the number of traditional herbal medicine purchasing.
2. Repeat for a value starting from 0.1 to 0.9.
3. Next, repeat the value of t starting from equal to 1 to a number of actual data.
4. If t is equal to 1, then the data is stored as the forecasting value for the 1st period. However, if t is not equal to 1, then the process of calculating the value of the forecast results is carried out using the Single Exponential Smoothing method formula.
5. After obtaining the value of the forecast results, the forecasting process is continued on the next t value.
6. Then, if the process of forecasting calculations for the entire period has been carried out, then proceed with forecasting calculations for the next alpha value.
7. Then, when the calculation has been carried out using the alpha value up to 0.9, the forecasting process using the Single Exponential Smoothing method has been completed.

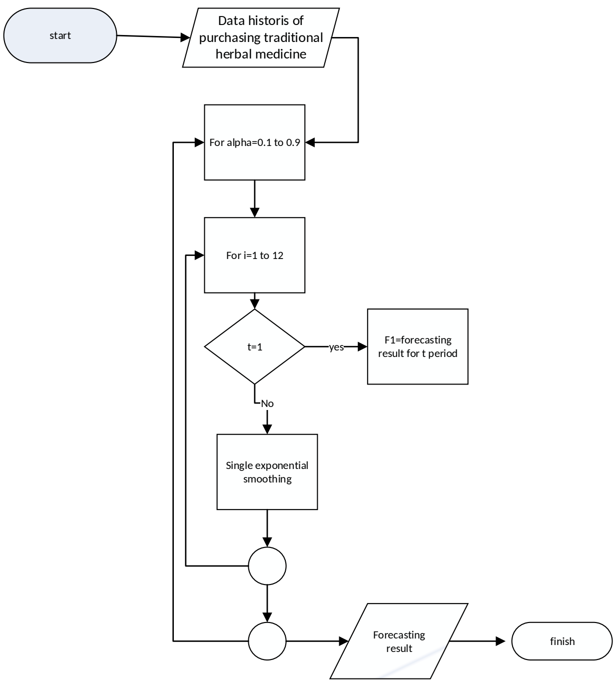

Fig. 4. Single exponential smoothing method

Measurement Error Prediction

No prediction achieves 100% accuracy, as every prediction inherently contains errors. Thus, to evaluate prediction methods for accuracy, it's essential to calculate the error rate. The smaller the margin of error, the higher the accuracy of the prediction method. Calculating prediction errors is integral to measuring accuracy in predictions.

Develop forecasting information system

To develop information system, we use system development life cycle (SDLC) approach, starting with analysis, design, implementation, and testing.

Results

Data Acquitition

The data used in this research is the number of herbal medicines purchase every week for the past year. As an example, we use data from August 2024 to October 2024. The following is an example of the data used in the study as shown in Table 1.

Table 1
Purchasing Data From August-October 2024

Week	Date	Galian rapat wangi	Galian singset	Tongkat Madura
1	01/08/23 – 05/08/23	52	12	67
2	07/08/23 – 12/08/23	64	11	69
3	14/08/23 – 19/08/23	74	12	65
4	21/08/23 – 26/08/23	70	9	75
5	28/08/23 – 02/09/23	65	10	66
6	04/09/23 – 09/09/23	66	9	84
7	11/09/23 – 16/09/23	62	10	78
8	18/09/23 – 23/09/23	56	11	97
9	25/09/23 – 30/09/23	52	10	100
10	02/10/23 – 07/10/23	54	9	95
11	09/10/23 – 14/10/23	59	10	94
12	16/10/23 – 21/10/23	55	12	107

Based on actual data above, set the alpha point:

$$\alpha = 2/(n+1) \tag{2}$$

α: smoothing constanta ($0 \leq \alpha \leq 1$)
n: Amount of actual data

Furthermore, forecasting calculations were performed using the Single Exponential Smoothing method.

According the purchasing data, we forecasted the value by using derived formula of single exponential method.

For example, we used α value 0.3.

1. First period forecasting (F_1): F_1 value is unidentified, so we can use first actual data (X_t) as first forecasting :
   $F_1 = X_t$
   $F_1 = 52$
2. Second period forecasting ($F2$):
   $F_{t+1} = \alpha \cdot X_t + (1 - \alpha) \cdot Ft$
   $F_{1+1} = 0.3 \cdot 52 + (1 - 0.3) \cdot 52$
   $F_2 = 52$
3. Third period forecasting (F_3):
   $F_{t+1} = \alpha \cdot X_t + (1 - \alpha) \cdot Ft$
   $F_{2+1} = 0.3 \cdot 64 + (1 - 0.3) \cdot 52$
   $F_3 = 55.60$

The complete result displayed in Table 2.

Based on the data above, we implemented a single exponential smoothing algorithm into information system applications to make it easier for users to interact with the system based on existing data. The following is an information system interface for forecasting the amount of traditional herbal medicine (jamu) production. This forecasting information system provides information of traditional herbal medicine (jamu) production in the future. So, it can control the amount of the stock of existing products. The lack or excess of stock products can be minimized. When the number of sales can be accurately predicted, the fulfillment of jamu consumers' demand can be achieved on time.

In Fig. 5 there is dashboard menu that allow user to manage jamu data.

In Fig. 6 there is jamu menu that allow user to choose type of jamu that want to forecast.

In Fig. 7 there is forecasting menu that provide information about the result of jamu forecasting. Including the accurate point of forecasting result (MAPE).

In Fig. 8 there is forecasting chart menu that provide alternative information presentation of forecasting result.

Fig. 5. Dashboard Menu

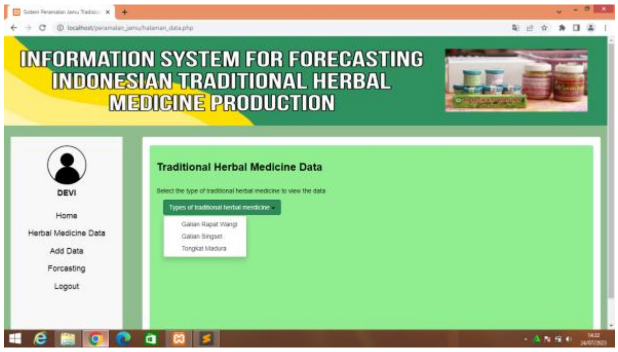

Fig. 6. Jamu Menu

Fig. 7. Forecasting Menu

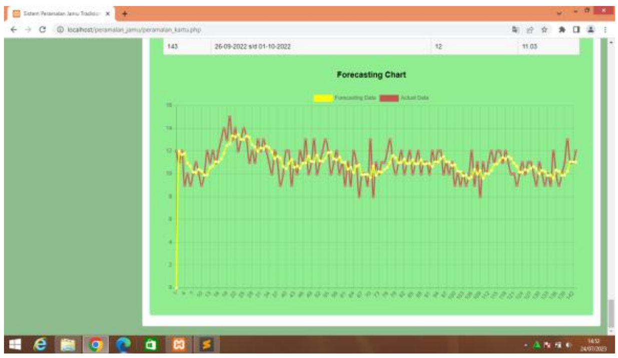

Fig. 8. Forecasting chart Menu

Discussion

Based on the results of this research, it is necessary to test the accuracy of the forecasting method. In many forecasting situations, accuracy is valued as a benchmark in rejecting the choice of forecasting method. In this study, the Mean Absolute Percentage Error (MAPE) method was used, a forecasting test method to calculate the percentage difference between the actual value and the forecasting value. In this calculation, it is assumed that the smaller error value produced is directly proportional to the higher accuracy of the

Table 2
Purchasing Data and forecasting result from August-October 2024

Week	Date	Galian rapat wangi	Forecast Result	Galian singset	Forecast result	Tongkat Madura	Forecast Result
1	01/08/23 – 05/08/23	52		12		67	
2	07/08/23 – 12/08/23	64	52	11	12	69	67
3	14/08/23 – 19/08/23	74	55.60	12	11.70	65	67.80
4	21/08/23 – 26/08/23	70	61.12	9	11.79	75	66.68
5	28/08/23 – 02/09/23	65	63.78	10	10.95	66	70.01
6	04/09/23 – 09/09/23	66	64.15	9	10.67	84	68.40
7	11/09/23 – 16/09/23	62	64.70	10	10.17	78	74.64
8	18/09/23 – 23/09/23	56	63.89	11	10.12	97	75.99
9	25/09/23 – 30/09/23	52	61.53	10	10.38	100	84.39
10	02/10/23 – 07/10/23	54	58.67	9	10.27	95	90.63
11	09/10/23 – 14/10/23	59	57.27	10	9.89	94	92.38
12	16/10/23 – 21/10/23	55	57.79	12	9.92	107,00	93,03

forecasting method used and vice versa. The following formula can be used to calculate MAPE (Chaerunnisa and Momon, 2024):

$$\text{MAPE} = \frac{100}{n} \sum_{t=1}^{n} \frac{|X_t - F_t|}{X_t} \tag{3}$$

F_t: Forecast result in t period
X_t: Actual data in t period
n: Amount of forecasting result data

The data used is a weekly report on the number of sales of 3 types of jamu from August 2024 to October 2024. The testing uses the Mean Absolute Percentage Error (MAPE) method. Data testing calculations were carried out starting from alpha 0.1 to alpha 0.9. The example of MAPE calculation is as follows:

1. Calculate the absolute value in first period by get difference value between actual data and forecasting result. Then divide with actual data and multiply with 100
   $\text{PE}_2 = \left(\frac{(|X_2 - F_2|)}{X_2}\right) \cdot 100$
   $\text{PE}_2 = \left(\frac{(|64 - 52|)}{64}\right) \cdot 100$
   $\text{PE}_2 = 18.75$
2. Calculate absolute value in third period until the end period.
3. Sum all the absolute value and divide with amount of actual data and forecasting result.

Table 3 shows the measurement result of jamu galian rapet wangi. Table 4 the measurement result of jamu galian singset. And Table 5 shows about measurement result of jamu tongkat madura.

Table 3
Measurement result of jamu galian rapet wangi

No	Alpha	Galian rapet wangi	
		Forecast	MAPE
1.	0.1	56.64	9.53%
2.	0.2	56.86	9.31%
3.	0.3	57.07	9.21%
4.	0.4	57.33	9.23%
5.	0.5	57.61	9.32%
6.	0.6	57.89	9.42%
7.	0.7	58.16	9.58%
8.	0.8	58.43	9.82%
9.	0.9	58.71	10.16%

Table 4
Measurement result of jamu galian singset

No	Alpha	Galian singset	
		Forecast	MAPE
1.	0.1	10.51	10.10%
2.	0.2	10.66	9.70%
3.	0.3	10.87	9.61%
4.	0.4	11.03	9.76%
5.	0.5	11.13	10.10%
6.	0.6	11.18	10.62%
7.	0.7	11.19	11.29%
8.	0.8	11.15	12.01%
9.	0.9	11.09	12.77%

Table 5
Measurement result of jamu tongkat madura

No	Alpha	Tongkat madura	
		Forecast	MAPE
1.	0.1	103.60	9.28%
2.	0.2	103.00	8.76%
3.	0.3	101.83	8.63%
4.	0.4	100.78	8.62%
5.	0.5	99.85	8.76%
6.	0.6	99.00	8.97%
7.	0.7	98.21	9.23%
8.	0.8	97.45	9.49%
9.	0.9	96.72	9.76%

The measurement table above illustrates the use of the Single Exponential Smoothing method with alpha values ranging from 0.1 to 0.9. The resulting Mean Absolute Percentage Error (MAPE) values fall within the ranges of "high" and "good" accuracy. Consequently, it can be inferred that the production forecasting yields accurate results, closely aligning with actual data. This accuracy makes it suitable for implementation, particularly in assisting small and medium enterprises in the traditional herbal medicine (jamu) industry. By utilizing this system, the industry can effectively plan herbal requirements, labor, and other resources for producing various types of traditional herbal medicine (jamu), thus meeting customer demand and enhancing productivity.

Conclusions

Based on the implementation and testing conducted in this study, the following conclusions can be drawn:

1. Testing the forecasting data using the Single Exponential Smoothing method reveals that the smallest Mean Absolute Percentage Error (MAPE) accuracy value is achieved with alpha set to 0.3 for three types of Jamu Madura.
2. Alpha values of 0.3 and 0.4 yield the smallest MAPE values due to the close alignment between forecasted and actual data values.
3. The MAPE accuracy value on the training data falls within the range of 1-10%, indicating a very good level of accuracy when the MAPE value is less than 10%.

Future research endeavors may explore alternative forecasting methods, such as other time series models or machine learning models, to identify the most accurate method for product forecasting. Additionally, this production forecasting approach can be applied to other products sharing similar characteristics with Indonesian traditional medicine (jamu), such as food and beverages.

Acknowledgment

This research has been supported by Department of Informatics Engineering, Trunojoyo University, Indonesia.

References

Abidin, Z., & Indriani, N. (2024). Jamu Herbal untuk Meningkatkan Imunitas Tubuh di Masa Pandemi Covid-19. *Jurnal Pembelajaran Pemberdayaan Masyarakat* (JP2M), 2(2), 106–110.

Afendi, F.M., Ono, N., Nakamura, Y., Nakamura, K., Darusman, L.K., Kibinge, N., & Kanaya, S. (2013). Data mining methods for omics and knowledge of crude medicinal plants toward big data biology. *Computational and Structural Biotechnology Journal*, 4(5), e201301010.

Amalia, F.A., & Aprianingsih, A. (2017). Business model of jamu as Indonesian traditional herbal medicine in new economy. *The Asian Journal of Technology Management*, 10(1), 19.

Anggoro, D., & Wulandari, W. (2019). Forecasting Demand Dengan Metode Single Exponential Smoothing Untuk Analisa Jumlah Penjualan Obat Ternak. *Simposium Nasional Ilmiah & Call for Paper Unindra* (Simponi), 1(1).

Arifin, Z., Yuliawati, F., & Syafrawi, F.N.U. (2016). IbM home industri jamu tradisional Madura untuk meningkatkan daya saing di Kabupaten Pamekasan. *J-Dinamika: Jurnal Pengabdian Masyarakat*, 1(2), 92–102.

Chaerunnisa, N. & Momon, A. (2024). Perbandingan Metode Single Exponential Smoothing Dan Moving Average Pada Peramalan Penjualan Produk. Jurnal Rekayasa Sistem Industri, *J. Rekayasa Sist. Ind.,* 6(2), 101–106.

Chatfield, K., Salehi, B., Sharifi-Rad, J., & Afshar, L. (2018). Applying an ethical framework to herbal medicine. *Evidence-based Complementary and Alternative Medicine*, 2018.

Dar, R.A., Shahnawaz, M., & Qazi, P.H. (2017). General overview of medicinal plants: A review. *The Journal of Phytopharmacology*, 6(6), 349–351.

de Oliveira, E.M., & Oliveira, F.L.C. (2018). Forecasting mid-long term electric energy consumption through bagging ARIMA and exponential smoothing methods. *Energy*, 144, 776–788.

Dharmawan, A., & Aji, G.G. (2018). Madurese cultural communication approach. In Journal of Physics: Conference Series (Vol. 953, No. 1, p. 012195). *IOP Publishing.*

Fuji, N. (2020). *Manfaat Empon-Empon untuk Kesehatan*, Tingkatkan Imunitas Tubuh.

Gunawan, R., & Mustofa, K. (2017). Finding Knowledge from Indonesian Traditional Medicine using Semantic Web Rule Language. *International Journal of Electrical & Computer Engineering* (2088-8708), 7(6).

Gustriansyah, R., Suhandi, N., Antony, F., & Sanmorino, A. (2019, March). Single exponential smoothing method to predict sales multiple products. *In Journal of Physics: Conference Series* (Vol. 1175, No. 1, p. 012036). IOP Publishing.

Hidayat, K. (2018). Modeling Information System for Agroindustry of Jamu Madura. *Teknika: Engineering and Sains Journal*, 2(1), 47–52.

Ikawati, Y. (2018). Strategi Pemasaran Produk Jamu pada Perusahaan Jamu Bisma Sehat Kabupaten Sukoharjo.

Karamina, H., Supriyadi, S., Yasin, D.D.F., Kamhar, M.Y., & Astuti, F.K. (2020). Pemanfaatan dan Penanaman Tanaman Obat Keluarga (TOGA) Menuju Keluarga Sehat Pada Ibu Pemberdayaan Kesejahteraan Keluarga (PKK). *Jurnal Inovasi Hasil Pengabdian Masyarakat* (JIPEMAS), 3(2), 120–127.

Kemenperin (2015). Kemenperin Optimis Industri Jamu Tembus Proteksi Ekspor. 27 Mei 2024, https://kemenperin.go.id/artikel/12152/Kemenperin.

La Fua, J. (2020). Jahe Peningkat Sistem Imun Tubuh di Era Pandemi Covid-19 di Kelurahan Kadia Kota Kendari: Ginger Improves the Body's Immune System During a Pandemic Covid-19 in a Village in Kendara City. *Jurnal Mandala Pengabdian Masyarakat*, 1(2), 54–61.

Liem, A., & Rahmawati, K.D. (2017). The meaning of complementary, alternative and traditional medicine among the Indonesian psychology community: A pilot study. *Journal of integrative medicine*, 15(4), 288–294.

Lusiana, A., & Yuliarty, P. (2020). Penerapan Metode Peramalan (Forecasting) pada Permintaan Atap di PT X. *Industri Inovatif: Jurnal Teknik Industri*, 10(1), 11–20.

Makridakis, S., Wheelwright, S.C. and V.E. McGEE (1999). Metode dan Aplikasi Peramalan Edisi Kedua Jilid Satu.

Margarethy, I., Yahya, Y., & Salim, M. (2019). Kearifan lokal dalam pemanfaatan tumbuhan untuk mengatasi malaria oleh pengobat tradisional di Sumatera Selatan. *Journal of Health Epidemiology and Communicable Diseases*, 5(2), 40–48.

Nazim, A., & Afthanorhan, A. (2014). A comparison between single exponential smoothing (SES), double exponential smoothing (DES), holt's (brown) and adaptive response rate exponential smoothing (ARRES) techniques in forecasting Malaysia population. *Global Journal of Mathematical Analysis*, 2(4), 276–280.

Ostertagová, Eva, (2011). *Modelling of Mechanical and Mechatronic systems, Technical University of Košice*, Faculty of Electrical Engineering and Informatics, Department of Mathematics and Theoretical Informatics, Němcovej 32, 042 00 Košice, Slovak republic.

Pan, S.Y., Zhou, S.F., Gao, S.H., Yu, Z.L., Zhang, S.F., Tang, M.K., & Ko, K.M. (2013). New perspectives on how to discover drugs from herbal medicines: CAM's outstanding contribution to modern therapeutics. *Evidence-Based Complementary and Alternative Medicine*, 2013.

Pertiwi, R., Notriawan, D., & Wibowo, R.H. (2020). Pemanfaatan tanaman obat keluarga (toga) meningkatkan imunitas tubuh sebagai pencegahan covid-19. *Dharma Raflesia: Jurnal Ilmiah Pengembangan Dan Penerapan IPTEKS*, 18(2), 110–118.

Prabhakaran, D., Jeemon, P., & Roy, A. (2016). Cardiovascular diseases in India: current epidemiology and future directions. *Circulation*, 133(16), 1605-1620.

Purwanti, E., Mahmudati, N., Faradila, S.F., & Fauzi, A. (2020, April). Utilization of plants as traditional medicine for various diseases: Ethnobotany study in Sumenep, Indonesia. *In AIP Conference Proceedings*, 2231(1)

Riswan, S., & Sangat-Roemantyo, H. (2002). Jamu as traditional medicine in Java, Indonesia. *South Pacific Study*, 23(1), 1–10

Rodrigues, E., & Barnes, J. (2013). Pharmacovigilance of herbal medicines: the potential contributions of ethnobotanical and ethnopharmacological studies. *Drug safety*, 36, 1–12.

Rohaniyah, J. (2016). The Study of Madurese Social Dialect. *Wacana Didaktika*, 4(2), 102–107.

Royhan, A., & Rum, M. (2022). Analisis nilai tambah dan business model canvas UKM Jamu Madura (Studi kasus UKM Al-Manshurien Kamal, Bangkalan). *Agriscience*, 3(2), 443–461.

Satriyati, E. (2017). Menjaga tradisi minum jamu Madura dengan penyampaian pesan interpersonal kesehatan antara peramu dan pengguna. *DIMENSI-Journal of Sociology*, 10(2).

Sumarni, W., Sudarmin, S., & Sumarti, S.S. (2019, October). The scientification of jamu: a study of Indonesian's traditional medicine. *In Journal of Physics: Conference Series*, 1321(3), 032057. IOP Publishing.

Susanto, B., Situmorang, H.Y., & Virginia, G. (2019, March). RDFS-based information representation of Indonesian traditional jamu. *In Lecture Notes in Engineering and Computer Science: Proceedings of The International MultiConference of Engineers and Computer Scientists*, 13–15

Wahidah, B.F. (2013). Etnobotani Tumbuhan Obat yang Dimanfaatkan oleh Masyarakat Kecamatan Tompobulu Kabupaten Gowa Sulawesi Selatan [UIN Alauddin].

Walonoski, J., Scanlon, R., Dowling, C., Hyland, M., Ettema, R., & Posnack, S. (2018). Validation and testing of fast healthcare interoperability resources standards compliance: Data analysis. *JMIR Medical Informatics*, 6(4), e10870.

Widyawaruyanti, A., Zaidi, S.F.H., Awale, S., & Kadota, S. (2007). Traditional medicine of Madura island in Indonesia. *Journal of traditional medicines*, 24(3), 90–103.

Woerdenbag, H.J., & Kayser, O. (2014). Jamu: Indonesian traditional herbal medicine towards rational phytopharmacological use. *Journal of herbal medicine*, 4(2), 51–73.

Yang, D.H., Kang, J.H., Park, Y.B., Park, Y.J., Oh, H.S., & Kim, S.B. (2013). Association rule mining and network analysis in oriental medicine. *PLOS one*, 8(3), e59241.

Zhao, X., Li, X., Yang, W., Feng, Q., Zhou, Y., & Wang, Q. (2018). Primary health information standard system based on semantic interoperability. *BMC medical informatics and decision making*, 18(5), 119–127.