

Web-Based Stock Forecasting Application Using Single Exponential Smoothing Method (Case Study: CV. Anugerah Ajitama)

Muchammad Ichwan Firdaus¹, Ardhini Warih Utami²

^{1,2}*Universitas Negeri Surabaya, Surabaya, Indonesia*

muchammadfirdaus.22082@mhs.unesa.ac.id, ardhiniwarih@unesa.ac.id

ABSTRACT

CV. Anugerah Ajitama, a building material distribution company, faces inventory management challenges due to stock determination that is still conducted manually based on subjective estimation. This condition has led to recurring overstock and stockout issues, resulting in increased storage costs, product damage risks, and lost sales opportunities. This study aims to design and develop a web-based inventory forecasting system utilizing the Single Exponential Smoothing (SES) method, as well as to evaluate the forecasting accuracy and system functionality. System development employs the Rapid Application Development (RAD) method, encompassing the stages of requirement planning, user design, construction, and cutover. The research data consists of historical sales data of three main products water tanks, turbine ventilators, and metal roof tiles from the January 2023 to December 2025 period. The forecasting process involves testing alpha values from 0.1 to 0.9 through a trial and error approach, with the best alpha selected based on the smallest Mean Squared Error (MSE), while Mean Absolute Deviation (MAD) serves as supplementary information. The results show that the optimal alpha values are 0.1 for water tanks (MSE: 13.70, MAD: 2.60), 0.2 for turbine ventilators (MSE: 5.12, MAD: 2.02), and 0.3 for metal roof tiles (MSE: 4932.58, MAD: 53.60). The system was successfully implemented as a web-based application built with Laravel and React, featuring product data management, stock realization, sales data management, automated forecasting, report generation, notifications, and role-based access control. Furthermore, functional testing using Black Box Testing across three user roles (Super Admin, Business Owner, and Admin Staff) with a total of 133 test scenarios was successfully executed with a 100% pass rate. Based on these findings, this application can effectively serve as a decision support tool for inventory planning at CV. Anugerah Ajitama.

Keyword: Single Exponential Smoothing, Inventory Forecasting, Web-Based Application, RAD, Black Box Testing, Mean Squared Error, Mean Absolute Deviation.

Article Info:

Article history:

Received April 15, 2026

Revised May 13, 2026

Accepted June 17, 2026

Corresponding Author

Muchammad Ichwan Firdaus

Universitas Negeri Surabaya, Surabaya, Indonesia

muchammadfirdaus.22082@mhs.unesa.ac.id

1. INTRODUCTION

Inventory management is a critical component of operational activities in trading companies, particularly those engaged in building material distribution. Inventory serves as a buffer between market demand uncertainty and the limited time for supplier fulfillment. Effective inventory management aims to ensure the availability of goods in the right quantity,

at the right time, and with efficient costs. Conversely, poorly planned inventory management can cause problems in the form of overstock or stockout, which impact increased storage costs, product damage risks, impeded capital turnover, and decreased levels of customer service [1].

With the increasing construction and housing development activities across various regions, demand for building materials has experienced significant fluctuations. This demand is not constant as it is influenced by various factors, such as weather conditions, construction project seasons, public purchasing power, and market trends. Unanticipated demand fluctuations can cause imbalances between available stock and actual needs in the field. Under these conditions, companies are required to have an inventory planning system capable of predicting stock needs more accurately by utilizing historical sales data as a basis for decision-making [2].

CV. Anugerah Ajitama is a company engaged in building material distribution with main products consisting of water tanks, turbine ventilators, and metal roof tiles. Based on pre-survey results and interviews conducted with the company, it was identified that the determination of purchase quantities and stock inventory is still carried out based on subjective estimation and previous experience. Historical sales data has not been optimally utilized as a basis for stock planning. This condition has caused the company to experience overstock on certain products several times, especially when demand decreases due to seasonal factors, as well as stockout during periods of high demand. The impacts of these problems include increased storage costs, product damage risks, and potential loss of sales due to unfulfilled customer demand [1], [3].

The uncertainty of future demand can be addressed through predictive modeling using time series forecasting methods [4]. Previous studies have demonstrated the effectiveness of the Single Exponential Smoothing (SES) method in inventory and sales forecasting. Budiman [1] showed that SES was able to forecast merchandise stock with relatively low error rates. Deni et al. [2] demonstrated that SES provided more accurate sales forecasting results compared to the Moving Average method, as SES is more responsive to recent data changes. Prayitno et al. [5] showed that integrating SES into a web-based information system could help companies monitor inventory and determine stock quantities in a more structured manner using Black Box Testing for system validation. Additionally, Wiranti and Dhamayanti [6] developed a web-based forecasting information system applying SES to building material sales data, achieving the best results with $\alpha = 0.9$ and evaluation using MAE and MSE. Furthermore, Kim and Kim [7] demonstrated the limitations of MAPE as an evaluation metric on data containing zero values, reinforcing the use of MSE and MAD as more stable and reliable alternative metrics.

Although the Single Exponential Smoothing method has been widely applied in various forecasting studies, its implementation for inventory forecasting in a building material distribution company focusing on water tanks, turbine ventilators, and metal roof tiles has not been specifically explored. Therefore, the novelty of this research lies in designing and developing a web-based inventory forecasting system using SES integrated into a website application with MSE and MAD as evaluation metrics and Black Box Testing for functional validation, specifically applied at CV. Anugerah Ajitama.

2. METHODS

This study is a Research and Development (R&D) project aimed at designing and developing a web-based inventory forecasting system by applying the Single Exponential

Smoothing algorithm. In its development process, this study utilizes the Rapid Application Development (RAD) method, as it significantly accelerates system creation through an iterative and flexible approach tailored to user requirements [8].

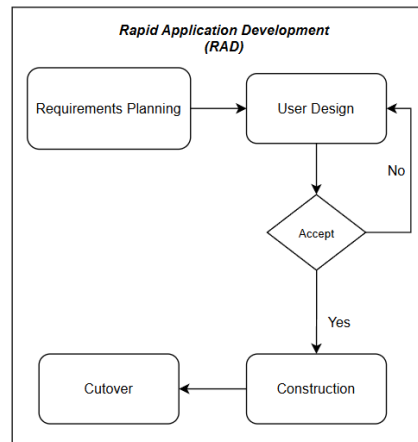


Figure 1. RAD Research Flow

The research phases are structured based on the RAD approach in Figure 1, which includes: requirements planning, interactive user design with the company, construction, and final testing and evaluation (cutover) [8].

2.1 Data Collection

The data collection in this study was obtained from interviews and observations conducted directly at CV. Anugerah Ajitama, located in Sidoarjo, East Java. Information gathering was carried out through semi-structured interviews with the business owner, which identified the core problems in stock determination and gathered primary historical records of product sales for the January 2023 to December 2025 period [9]. The research data consists of daily sales transactions that were aggregated into monthly sales data per product. The three products used in the forecasting process are water tanks, turbine ventilators, and metal roof tiles.

2.2 Unified Modeling Language (UML)

For crafting the software blueprint, this research uses Unified Modeling Language (UML) as a visual modeling language to specify the structure and behavior of the system [10]. The developed UML diagrams include a use case diagram to model user interactions, an activity diagram to illustrate system activity flows, a sequence diagram to display the message sequences between objects, and a class diagram to explain the static structure of the system [10].

2.3 Single Exponential Smoothing (SES)

The forecasting model training is executed using the Single Exponential Smoothing (SES) method. This method performs data smoothing by combining the actual value of the most recent period with the forecast value from the previous period through a smoothing constant (alpha). The SES formula is expressed as [1], [2]:

$$F_{t+1} = \alpha X_t + (1 - \alpha)F_t \quad (1)$$

Description:

F_{t+1} : Forecast value for the next period.

α : Smoothing constant ($0 < \alpha < 1$).

X_t : Actual value at period t.

F_t : Forecast value at period t.

The alpha parameter plays an important role in determining the sensitivity of the forecasting results to changes in actual data. A value of α closer to 1 causes the forecast to be more responsive to recent data changes, while a value closer to 0 produces smoother and more stable forecasts [2]. In this study, the alpha value is determined using a trial and error approach, testing nine values from 0.1 to 0.9 to obtain the alpha that produces the smallest forecasting error [3].

2.4 Forecasting Evaluation Metrics

The forecasting model's performance is evaluated using two quantitative metrics [1], [2]. First, the Mean Squared Error (MSE) metric measures the average squared difference between the predicted and actual values [1], [2], expressed as:

$$MSE = \frac{1}{n} \sum_{i=1}^n (X_i - F_i)^2 \quad (2)$$

Description:

X_i : Actual data for period i.

F_i : Forecast value for period i.

n : Number of data periods.

Second, the Mean Absolute Deviation (MAD) metric calculates the average absolute error of the differences between actual and forecast values [2], [4], derived from the equation:

$$MAD = \frac{1}{n} \sum_{i=1}^n |X_i - F_i| \quad (3)$$

Description:

X_i : Actual data for period i.

F_i : Forecast value for period i.

n : Number of data periods.

In this study, the best alpha is selected based on the smallest MSE value, as MSE assigns greater weight to larger errors. MAD is used as supplementary information showing the average absolute deviation between actual data and forecasting results in sales units [1], [2].

2.5 Technology Stack

The application is developed using Laravel 12 as the backend framework, implementing the Model-View-Controller (MVC) architecture pattern for separating application logic, display, and data management [11]. React 19 is utilized as the frontend library to build a dynamic and interactive user interface [12]. PostgreSQL 15 serves as the relational database management system for storing sales data, user data, and forecasting results [13].

2.6 Black Box Testing

For system functionality testing, the Black Box Testing method is used to ensure all features operate according to the company's requirements without examining the internal code structure [14]. This testing is implemented through the Equivalence Partitioning technique,

which divides test data into several groups with similar characteristics to validate the input, process, and output of each application feature [14].

3. RESULTS AND DISCUSSION

This section presents the system development outcomes, structured into four main phases. The discussion begins with the problem and system requirements analysis, followed by data preprocessing, SES calculation and alpha testing, user interface implementation, and concludes with the Black Box Testing results.

3.1 Problem and System Requirements Analysis

Based on interviews with the business owner of CV. Anugerah Ajitama, the determination of stock quantities relies on conventional estimation considering previous experience and seasonal factors. This approach caused inventory imbalance issues, resulting in either overstock or stockout conditions, which led to increased storage costs and lost sales opportunities. To mitigate this, a web-based forecasting system using the Single Exponential Smoothing method is developed.

Identified functional requirements include:

1. Input, verification, and storage of historical sales data within a PostgreSQL database.
2. Automated SES forecasting calculation with alpha trial and error testing.
3. Computing and displaying accuracy metrics (MSE, MAD).
4. Report generation in PDF format.
5. Notification system for stock minimum alerts and operational activities.
6. Secure user login authentication with role-based access control.

Non-functional requirements include:

1. Efficient data processing with stable forecasting outputs.
2. Intuitive user interface for non-technical users.
3. Data protection through authentication and accessible via cross-device web browsers.

User activities within the system are restricted based on three primary roles:

1. Super Admin: manages user accounts and has full access to view all operational data, run forecasting, and print reports.
2. Business Owner: manages stock realization, views sales data, runs forecasting process, views results, and prints reports.
3. Admin Staff: manages product data and sales data with full CRUD operations, and views stock realization in read-only mode.

3.2 Use Case Diagram

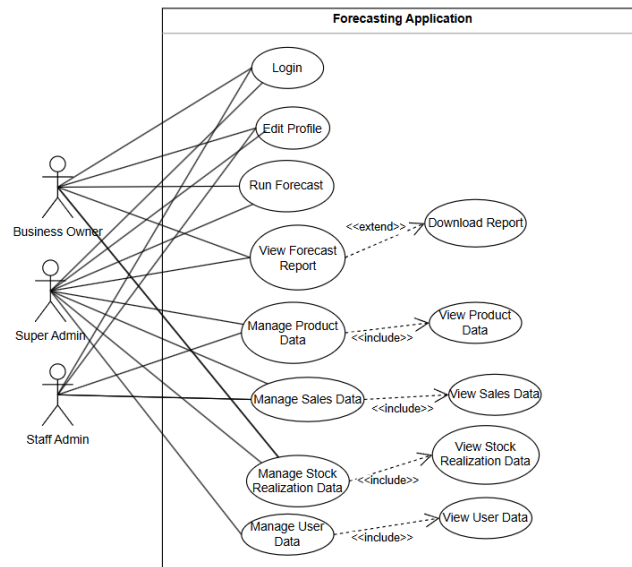


Figure 2. Use Case Diagram of the Forecasting Application

Based on Figure 2, the system restricts functionalities into three distinct roles. The Super Admin handles user management and has full data access, the Business Owner manages stock realization, forecasting execution, and report printing, and the Admin Staff manages product data administration and sales data (CRUD operations). Additionally, all actors must undergo application login to access the application and users can receive notifications.

3.3 Data Preprocessing and SES Calculation

Table 1. Dataset of Sales Period 2023 - 2025

Period	Tandon Air	Turbin Ventilator	Genteng Metal
Jan-23	9	0	0
Feb-23	8	5	136
Mar-23	7	4	144
Apr-23	0	4	166
...			...
Dec-25	9	4	171

The historical sales dataset from CV. Anugerah Ajitama for the January 2023 to December 2025 period was used for the forecasting process. Daily sales transactions were aggregated into monthly sales data grouped by product. The dataset contains sales records for three products: water tanks, turbine ventilators, and metal roof tiles.

The system performs alpha testing from 0.1 to 0.9 through a trial and error approach for each product. For each alpha value, the system calculates the SES forecast, computes error metrics (MAD and MSE), and selects the alpha with the smallest MSE as the best parameter.

The first period is used as the initial forecast value, so error calculation begins from the second period. The recapitulation of the best alpha values and forecasting results for each product is presented in Table 2.

Table 2. Best Alpha Recapitulation

Product	Best Alpha	MSE	MAD	Forecast (Next Period)
Water Tank	0.1	13.7007	2.6028	9 units
Turbine Ventilator	0.2	5.1245	2.0196	4 units
Metal Roof Tile	0.3	4932.58	53.6008	134 units

Based on Table 2, each product yields a different optimal alpha value due to their distinct sales patterns. Metal roof tiles have larger MAD and MSE values because their sales volume is higher and fluctuations are more significant, whereas water tanks and turbine ventilators have smaller error values due to their lower unit sales range.

3.4 User Interface and Implementation

This section discusses the visual and functional deployment of the application's main features, which encompass login, dashboard, and forecasting.

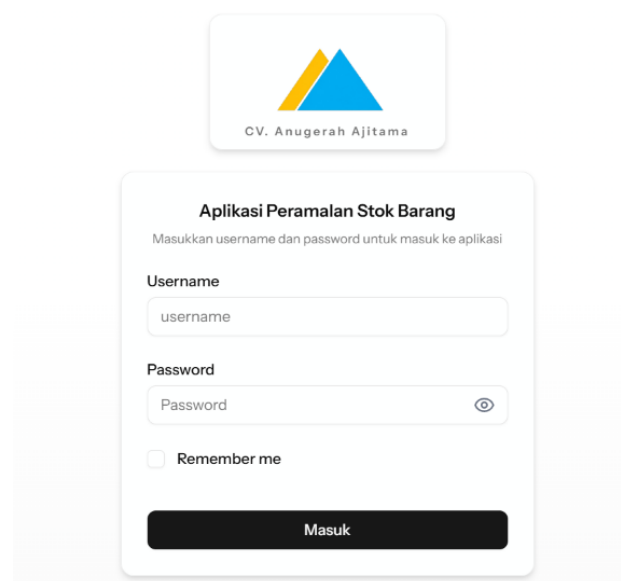


Figure 3. Login Page Application

The login page serves as the gateway to secure the application, restricting access to three authorized user roles (Super Admin, Business Owner, and Admin Staff) using credentials stored in the database. Users input their credentials into the login interface, and the system validates the data against the database before redirecting to the appropriate role-based dashboard.

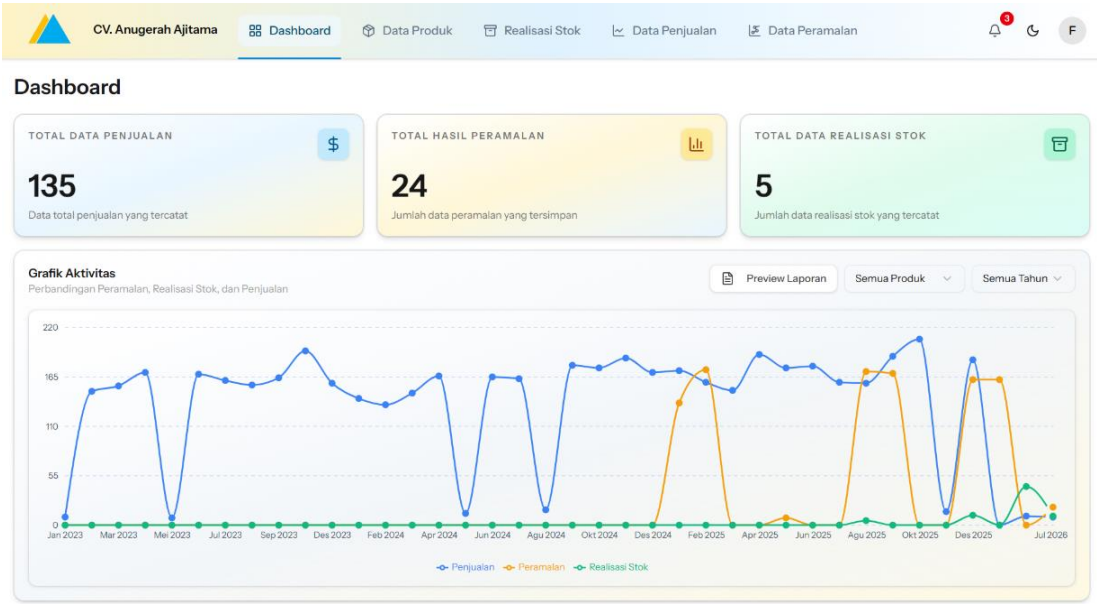


Figure 4. Dashboard Business Owner

The dashboard for the Business Owner displays a summary of key operational data, including total sales data, total forecasting results, and total stock realization. Additionally, it features a product activity chart providing a combined visualization of sales, forecasting, and stock data to support decision-making regarding stock planning.

The forecasting data page displays a table of forecasting results. The table includes columns for 'NO', 'TANGGAL', 'PERIODE', 'PRODUK', 'SUMBER', 'NILAI PERAMALAN', and 'AKSI'. The data is filtered by 'Semua Produk' (All Products), 'Semua Bulan' (All Months), and 'Semua Tahun' (All Years). The table shows 10 rows of forecasting data, including products like 'Tandon Air', 'Turbin Ventilator', and 'Genteng Metal'. The 'NILAI PERAMALAN' (Forecasting Value) ranges from 0 to 133. The 'AKSI' (Action) column includes buttons for 'Hitung Peramalan' (Calculate Forecast) and 'Cetak' (Print).

NO	TANGGAL	PERIODE	PRODUK	SUMBER	NILAI PERAMALAN	AKSI
1	05 Jul 2026	Juli 2026	Tandon Air	Per Produk	9	Detail Delete
2	02 Jul 2026	Juli 2026	Tandon Air	Semua Produk	9	Detail Delete
3	02 Jul 2026	Juli 2026	Turbin Ventilator	Semua Produk	0	Detail Delete
4	02 Jul 2026	Juli 2026	Genteng Metal	Semua Produk	2	Detail Delete
5	30 Jun 2026	Desember 2025	Tandon Air	Semua Produk	11	Detail Delete
6	30 Jun 2026	Januari 2025	Tandon Air	Semua Produk	1	Detail Delete
7	30 Jun 2026	Januari 2025	Genteng Metal	Semua Produk	133	Detail Delete
8	30 Jun 2026	Januari 2025	Turbin Ventilator	Semua Produk	2	Detail Delete
9	29 Jun 2026	Mei 2025	Tandon Air	Semua Produk	8	Detail Delete
10	23 Jun 2026	September 2025	Tandon Air	Semua Produk	8	Detail Delete

Figure 5. Forecasting Data Page

The forecasting data page is accessible by the Business Owner and Super Admin. It displays forecasting results in a table containing period, product, forecasting source, and forecast value information. The page includes a "Calculate Forecast" button to run new forecasting processes, a "Print" button for generating forecast report PDFs, and action columns for viewing details or deleting forecasting data. The detail modal shows comprehensive forecasting information including product, start period, end period, alpha, forecast value, MAD, and MSE.

3.5 Black Box Testing

The Black Box Testing results of the inventory forecasting website were categorized into three user roles: Super Admin, Business Owner, and Admin Staff. The testing involved actual users from CV. Anugerah Ajitama according to their respective access authorities. The results showed that all 133 test cases were successfully executed and produced the expected outcomes, indicating that all website functions operated correctly, including login and authentication, dashboard visualization, product data management, stock realization management, sales data management with automatic stock adjustment, forecasting calculation and reporting, notification system, user management, profile management, and role-based access features.

CONCLUSION

This research successfully achieved all its objectives by developing a web-based inventory forecasting system using the Single Exponential Smoothing method at CV. Anugerah Ajitama. The system features product data management, stock realization, sales data, automated forecasting, PDF report generation, notifications, user management, and profile settings, with role-based access control across three user roles: Super Admin, Business Owner, and Admin Staff.

The Single Exponential Smoothing method was successfully implemented in an automated manner within the system. The forecasting process automatically retrieves 12 months of historical sales data based on the target month selected by the user, tests alpha values from 0.1 to 0.9, and selects the best alpha based on the smallest MSE value. The evaluation results show that each product has a different optimal alpha: 0.1 for water tanks (MSE: 13.70, MAD: 2.60), 0.2 for turbine ventilators (MSE: 5.12, MAD: 2.02), and 0.3 for metal roof tiles (MSE: 4932.58, MAD: 53.60). The forecasting results provide quantitative estimates of stock needs, enabling the company to make more data-driven purchasing decisions.

From a development standpoint, the system was built using the Rapid Application Development (RAD) method with Laravel 12 as the backend framework and React 19 as the frontend library, and successfully passed all 133 Black Box Testing scenarios across three user roles with a 100% pass rate, confirming that every feature and function operates as intended. Academically, this study contributes to the application of Single Exponential Smoothing in building material inventory forecasting, while practically serving as a decision-support tool for CV. Anugerah Ajitama in planning product stock quantities.

Future research may further improve the system by adding data export features in Excel or CSV format, implementing real-time notifications using WebSocket technology, utilizing historical data with longer periods and more product varieties, and comparing Single Exponential Smoothing with other forecasting methods to identify a more optimal approach.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to Allah SWT, whose grace and blessings made the completion of this research possible. The author also extends appreciation to CV. Anugerah Ajitama for their willingness to serve as the research object and for providing the necessary data and support throughout the study. Special thanks are also due to Mrs.

Ardhini Warih Utami, S.Kom., M.Kom., as the research supervisor, whose guidance, input, and encouragement were invaluable in the completion of this article.

REFERENCES

- [1] S. N. Budiman, "Peramalan Stock Barang Dagangan Menggunakan Metode Single Exponential Smoothing," *Jurnal Teknologi dan Manajemen Informatika*, 2021, doi: 10.26905/jtmi.v7i2.6727.
- [2] D. Reskianto, M. A. Barata, and Sahri, "Forecasting Metode Single Exponential Smoothing dalam Meramalkan Penjualan Barang," *Jurnal Informatika Polinema*, vol. 9, no. 4, pp. 435–444, 2023, doi: 10.33795/jip.v9i4.1405.
- [3] E. Nuryani, R. Rudianto, R. Budiman, and E. Lazuardi, "Peramalan Persediaan Obat Menggunakan Metode Single Exponential Smoothing," *JSiI: Jurnal Sistem Informasi*, vol. 9, no. 2, pp. 186–192, 2022, doi: 10.30656/jsii.v9i2.4486.
- [4] E. S. D. Gulo, T. H. S. Hulu, S. M. Kakisina, and M. S. D. Mendrofa, "Analisis Peramalan Persediaan Barang Menggunakan Metode Moving Average dan Exponential Smoothing pada CV. Sanjaya Bangun Pratama," *Jurnal Ekonomi Bisnis, Manajemen dan Akuntansi (JEBMA)*, vol. 4, no. 3, 2024.
- [5] B. Prayitno, P. Palupiningsih, H. A. M. Khoharudin, and B. S. Munir, "Penerapan Algoritma Single Exponential Smoothing untuk Peramalan Stok Barang pada Sistem Informasi Berbasis Web," *PETIR: Jurnal Pengkajian dan Penerapan Teknik Informatika*, vol. 17, no. 1, pp. 133–142, 2024, doi: 10.33322/petir.v17i1.2377.
- [6] N. G. Antika, W. Winarsih, and N. D. Nathasia, "Implementasi Metode Single Exponential Smoothing (SES) Pada Aplikasi Inventory Berbasis Web," *E-Jurnal JUSITI (Jurnal Sistem Informasi dan Teknologi Informasi)*, vol. 13, no. 2, 2025.
- [7] N. J. Aziza, "Perbandingan Metode Moving Average, Single Exponential Smoothing, dan Double Exponential Smoothing pada Peramalan Permintaan Tabung Gas LPG PT Petrogas Prima Services," *Jurnal Teknologi dan Manajemen Industri Terapan*, vol. 1, no. 1, pp. 35–41, 2022.
- [8] A. Putri, Z. Wulansari, and U. Mawaddah, "Prediksi Stok Barang Pada Toko Gudang Cangkring Menggunakan Metode Rapid Application Development (RAD)," *Jurnal Komputer, Informasi dan Teknologi*, vol. 5, no. 2, pp. 1–17, Oct. 2025, doi: 10.53697/jkomitek.v5i2.3065.
- [9] A. Rivaldi, "Metode Pengumpulan Data Melalui Wawancara," *Uinsu*, Jan. 2024. [Online]. Available: <https://www.academia.edu/121718606/>
- [10] S. W. Ramdany, S. Aulia Kaidar, B. Aguchino, C. Amelia, A. Putri, and R. Anggie, "Penerapan UML Class Diagram dalam Perancangan Sistem Informasi Perpustakaan Berbasis Web," *Journal of Industrial and Engineering System*, vol. 5, no. 1, pp. 30–41, Jul. 2024, doi: 10.31599/2e9afp31.
- [11] A. Saputra and M. Y. Rangkuti, "Analisis dan Implementasi Bahasa Pemrograman PHP dalam Pengembangan Aplikasi Web Modern," *Kohesi: Jurnal Multidisiplin Saintek*, vol. 10, no. 6, pp. 1–6, 2025, doi: 10.8734/Kohesi.v1i2.365.
- [12] Nasution and L. Iswari, "Penerapan React JS pada Pengembangan Frontend Aplikasi Startup Ubaform," *Jurnal Informatika*, vol. 15, no. 2, pp. 1–8, 2021.
- [13] M. R. Efda and I. Nuryasin, "Pengujian Aplikasi Scantion Menggunakan Metode Blackbox dengan Teknik Equivalence Partitioning," *Jurnal Teknologi Sistem Informasi dan Aplikasi*, vol. 7, no. 2, pp. 115–124, 2024.
- [14] J. Fahmi Idris et al., "Pengujian Fungsional dan Struktural Aplikasi Pengajuan Cuti

- dengan Metode Black Box dan White Box," *Naratif: Jurnal Nasional Riset, Aplikasi dan Teknik Informatika*, vol. 7, no. 1, pp. 1–10, 2025.
- [15] N. P. L. Santiari and I. G. S. Rahayuda, "Analisis Perbandingan Metode Single Exponential Smoothing dan Single Moving Average dalam Peramalan Pemesanan," *Jurnal Informatika Universitas Pamulang*, vol. 6, no. 2, pp. 312–318, 2021.
- [16] A. Rahmad, Zulfachmi, and Desi, "Sistem Prediksi Pengadaan Bahan Bangunan Menggunakan Metode Single Exponential Smoothing pada Toko Jaya Indah Bangunan Tanjungpinang," *Jurnal Bangkit Indonesia*, vol. 13, no. 1, pp. 46–52, 2024.
- [17] F. W. Ichsan, M. Dasuki, and H. A. Al Faruq, "Penerapan Metode Single Exponential Smoothing sebagai Pendukung Keputusan Peramalan Penjualan Krupuk di UD. Syam Jaya," *JASIE: Jurnal Aplikasi Sistem Informasi dan Elektronika*, 2021.