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Online Store Web Software Engineering with Sales Forecasting Implementation

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ABSTRACT

This research focuses on the development of a web-based online store system with the implementation of a sales forecasting feature to support the business operations of UMKM Fay Brownies. The system was designed using the Extreme Programming (XP) software development method, which emphasizes an iterative, collaborative, and adaptive approach to changing user requirements. Several technology stacks were utilized in the development, including Next.js, Laravel, Django, and MySQL. The main features of the application include user authentication, shopping cart, ordering, payment, shipping cost calculation, automatic notifications via WhatsApp, and an admin dashboard for managing business aspects such as products and sales. The system is equipped with a sales forecasting module that employs seven methods: ARIMA, Single Exponential Smoothing, Simple Moving Average, Double Moving Average, Weighted Moving Average, Long Short-Term Memory (LSTM), and Auto Regressive models to predict product sales based on historical data. System evaluation showed that the application successfully meets user needs in conducting transactions easily and securely, while also providing accurate sales forecasts to support decision-making regarding raw material stock and business planning. The results of this study are also expected to serve as a reference for the development of e-commerce applications with forecasting capabilities that can be adopted by other small and medium-sized businesses.

Keyword: Online store, Sales forecasting, Extreme programming, ARIMA, LSTM, Moving Average, Auto Regressive

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1. INTRODUCTION

The advancement of information technology has brought significant changes across various business sectors, one of which is the digital transformation among Micro, Small, and Medium Enterprises (MSMEs). In Indonesia, MSMEs serve as a crucial pillar of the national economy due to their substantial contribution to Gross Domestic Product (GDP) and their role in absorbing a large portion of the workforce. However, many MSME actors still face challenges in effectively marketing their products and efficiently managing business operations.

One of the major challenges encountered by MSMEs is market demand uncertainty, which complicates production planning and raw material inventory management. This issue can lead to the risks of overstocking or stockouts, ultimately affecting customer satisfaction and business

profitability. Therefore, there is a need for a technology-based solution that can assist MSMEs in improving operational efficiency while providing accurate demand forecasting.

A web-based online store has emerged as a strategic solution for MSMEs to expand market reach, enhance product visibility, and streamline transaction processes. Additionally, integrating a sales forecasting feature using historical data can provide added value in planning production and procurement more precisely. By leveraging statistical methods such as ARIMA, Simple Exponential Smoothing (SES), and Single Moving Average, sales predictions can be made with sufficient accuracy.

This research aims to develop a web-based online store system that functions not only as a transaction platform but also includes forecasting capabilities to support data-driven business decision-making. The system development process employs the Extreme Programming (XP) methodology to ensure that the resulting application aligns with user needs and remains adaptable for future enhancements. It is expected that this system will serve as a reference for the use of information technology in supporting MSME development in the digital era.

2. METHODS

2.1 System Planning

This research focuses on the development of a web-based online store system integrated with a sales forecasting module to support the business operations of UMKM Fay Brownies. The initial stage involved system planning, where both functional and non-functional requirements were identified as the foundation for system development. Functional requirements include features such as product pages displaying detailed information, product search and filtering by category, shopping cart functionality, a checkout process with shipping address and cost calculation via RajaOngkir API, digital payment integration using Midtrans API, automatic notifications through WhatsApp Gateway API, order tracking for customers, and an admin dashboard for managing products, orders, reports, and sales forecasting. Non-functional requirements encompass performance criteria such as a page response time under five seconds, data security through encryption and protection against XSS and SQL injection attacks, system availability except during maintenance periods, a responsive design accessible on both desktop and mobile devices, as well as a scalable architecture and modular, well-documented code structure to ensure ease of maintenance and future development.

2.2 Technology Stack

The technology stack used in this research consisted of modern and reliable tools. On the frontend, HTML, CSS, JavaScript, Bootstrap, React.js, and Next.js were used to create a dynamic and responsive user interface. For the backend, Laravel and Django frameworks were selected to provide RESTful APIs for communication between the frontend and database. MySQL and PostgreSQL served as relational databases to store user information, product details, order records, and other relevant data. External services such as RajaOngkir API, Midtrans API, and WhatsApp Gateway API were integrated to support real-time delivery cost calculation, secure payment processing, and automated user notifications, respectively. In the forecasting module, Python programming language along with libraries like Pandas, NumPy, Statsmodels, Scikit-learn, and TensorFlow/Keras were used to implement and evaluate multiple forecasting models.

2.3 System Design

The system design phase aimed to define the logical and visual structure of the web-based online store before implementation began.

a. Use Case Diagram
A use case diagram was created to illustrate the interactions among the three main actors in the system, that is Admin, User, and Guest. The diagram helped identify the functionalities available to each user role and ensured that the system met the needs of all stakeholders. The Admin has full access to manage products and categories, view dashboards and reports, manage orders, respond to discussions and reviews, and perform sales forecasting. The User can browse products, search and filter items based on category, add products to the cart, proceed to checkout and payment, and provide product ratings and reviews. Meanwhile, the Guest has limited access and can only view products, register a new account, and reset password.

b. Database Design
The database structure was designed using an Entity Relationship Diagram (ERD) to ensure well-defined relationships between data entities. Key tables include Users, Products, Orders, Carts, Categories, Order Details, Product QnA, Product Reviews, Payments, Provinces, Cities, Forecasting Method Products, Delivery Details, OTP Forgot Password, Train Test Data, and Forecasting Methods. Each table is interconnected through defined relationships to support all application functions effectively and efficiently. This design ensured data integrity, minimized redundancy, and allowed for scalability and ease of maintenance as the system evolved over time.

2.4 Extreme Programming

Extreme Programming (XP) was chosen as the software development methodology due to its iterative and collaborative approach, which allows rapid adaptation to changing requirements throughout the development process. The system was developed in several structured iterations to ensure it was built gradually and aligned with user needs. Below is a summary of each iteration:

Table 1. Iteration

Iteration	Features Developed	Output
1	Database design	Structured and optimized database according to requirements
2	Development environment setup	Ready-to-use application development environment
3	Authentication and authorization	Secure authentication and role-based access control
4	Profile and password management	Secure and responsive profile and password editing features
5	Product and category management	Well-managed product and category data
6	Registered account information	Display of user account list with limited personal information
7	Frontend for users	Informative and responsive frontend pages for users
8	Shopping cart	Integrated and interactive shopping cart feature

9	Discussion or Q&A section	Recorded and organized discussion system; users can ask questions, admins can reply
10	Checkout process	Smooth and integrated checkout process
11	RajaOngkir API integration	Accurate and real-time shipping cost calculation up to district level
12	Midtrans API integration	Verified, secure, and smooth payment process
13	Midtrans webhook management	Automatic and real-time payment status updates
14	Order status and history	Structured and informative order history page
15	Order management	Efficient and integrated order management system
16	Sales report generation	Clear report supporting decision-making
17	WhatsApp API integration	Automated WhatsApp notifications sent as needed
18	Rating and review feature	Product reviews stored properly for product evaluation
19	Forecasting modeling	Ready-to-use forecasting model for building the best prediction per product
20	Sales forecasting	Responsive data processing that produces forecast results
21	Admin dashboard page	Displays concise information about orders, revenue, recent users, and latest reviews

2.5 Data Collection

Data collection was conducted through direct observation and interviews with stakeholders at UMKM Fay Brownies. Observation was used to understand the current business processes and how raw material stock had previously been managed manually. In addition, interviews were conducted with the business owner to identify operational challenges and expectations for the system, with administrators to obtain technical information regarding required features, and with customers to understand user needs and expectations related to the online shopping experience.

2.6 Data Preprocessing

Before the forecasting process could begin, historical sales data underwent preprocessing to ensure quality and readiness for modeling. Missing or unavailable values in the dataset were filled with the average of surrounding data points to avoid disrupting forecasting accuracy, ensuring the continuity and reliability of the data. The dataset was then divided into two parts: 80% for training data and 20% for testing data. The training data was used to train the forecasting model to capture patterns from historical data, while the testing data was utilized to evaluate the model's predictive

capability on unseen data. This step was crucial in ensuring that the resulting model not only accurately represented past data but also possessed strong generalization ability for predicting future sales.

2.7 Sales Forecasting Process

The forecasting process was carried out to predict product sales over the next three weeks to support decision-making regarding production planning and raw material inventory management. Seven different forecasting methods were applied to build the prediction model: ARIMA (Autoregressive Integrated Moving Average), Simple Exponential Smoothing (SES), Single Moving Average (SMA), Double Moving Average (DMA), Weighted Moving Average (WMA), Auto Regressive (AR), and Long Short-Term Memory (LSTM). Each method has unique characteristics in capturing historical data patterns, leading to varying levels of prediction accuracy.

To determine the best-performing model, each method was evaluated using the Mean Absolute Error (MAE) metric, which calculates the average absolute difference between actual and predicted values. The formula for MAE is:

$$\mathbf{MAE = (\Sigma\ |yi - \hat{y}i|) / n}$$

Where:

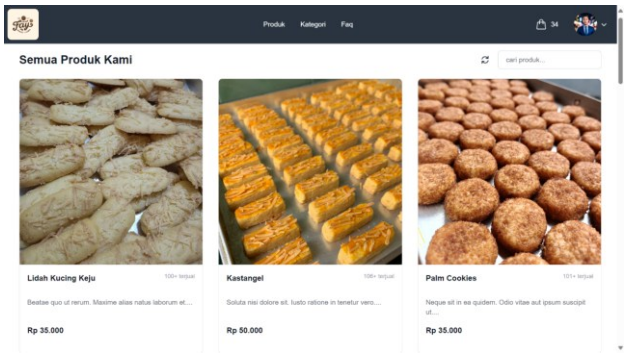
- yi = actual value
- $\hat{y}i$ = predicted value
- n = number of data points

The model with the lowest MAE was selected as the best model because it indicated the smallest and most consistent error in capturing sales trends. Once the best model was determined, the system performed forecasting for the next three weeks based on the historical sales dataset. The results were displayed in tabular and graphical formats for easy reading and analysis. After the forecasting period, actual sales data were collected and compared with predictions to validate the model's accuracy. Although some deviations occurred especially in the third week for certain products the forecasting model generally produced accurate and reliable results that supported operational and strategic decision-making at UMKM Fay Brownies.

3. RESULTS AND DISCUSSION (12 PT)

3.1 System Implementation

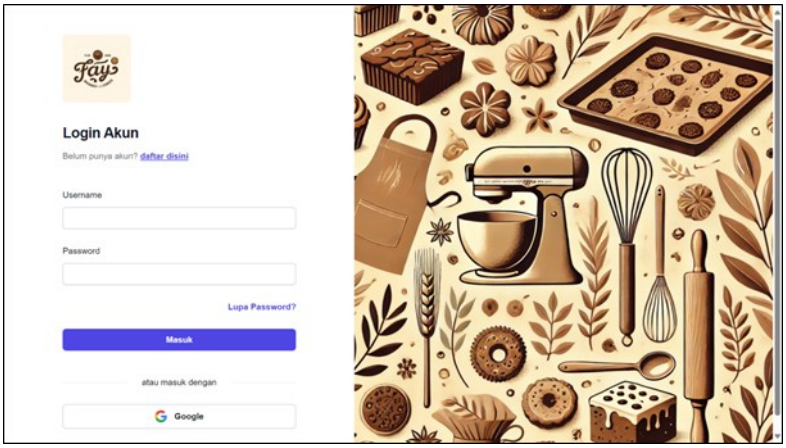
1. User Frontend Interface



Picture 1. Frontend User

The user frontend interface was designed to be visually appealing in order to attract potential buyers. This section does not require login access, making it easy for visitors to browse and explore the available products.

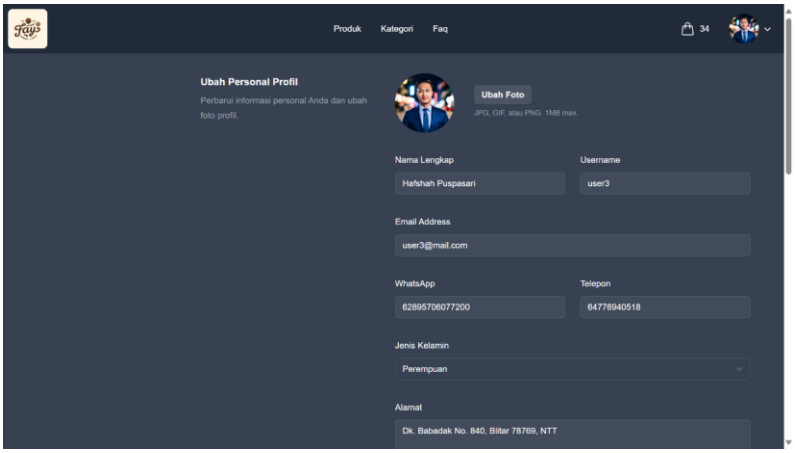
2. Authentication



Picture 2. Authentication

Authentication and authorization at the initial stage aim to verify whether a user has the required access rights and to differentiate between user roles. If a user does not have proper authorization, their access to the application will be limited accordingly.

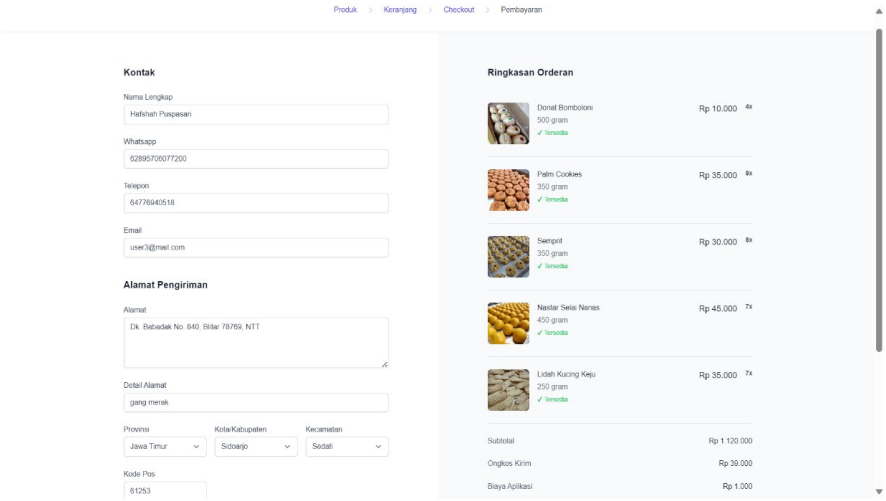
3. Profile Page



Picture 3. Profile Page

The profile page displays essential user information needed during the ordering process. Since personal data is required to complete purchases, this section ensures that all necessary buyer details are provided accurately.

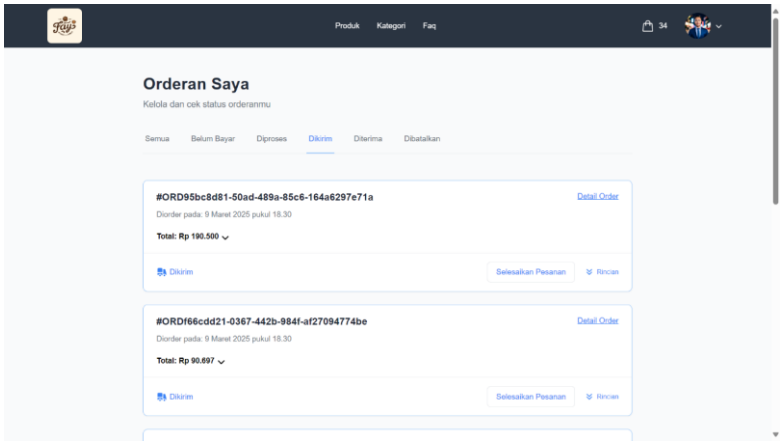
4. Checkout Page



Picture 4. Checkout

The checkout page requires users to enter necessary information in order to proceed with their orders. Detailed information regarding product items and total prices is clearly displayed to ensure transparency and smooth transaction processing.

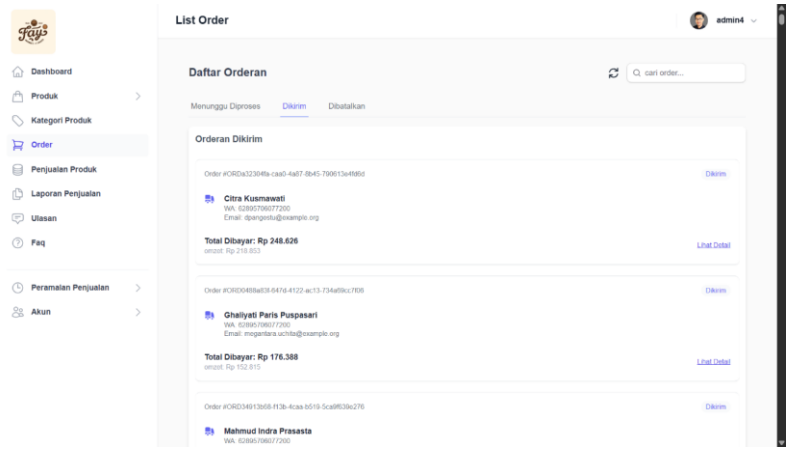
5. Order Status and History



Picture 5. Order History

This section provides an overview of the order status and serves as a central point for managing user transactions. It offers a comprehensive view of current and past orders, enabling users to track the progress of their purchases effectively.

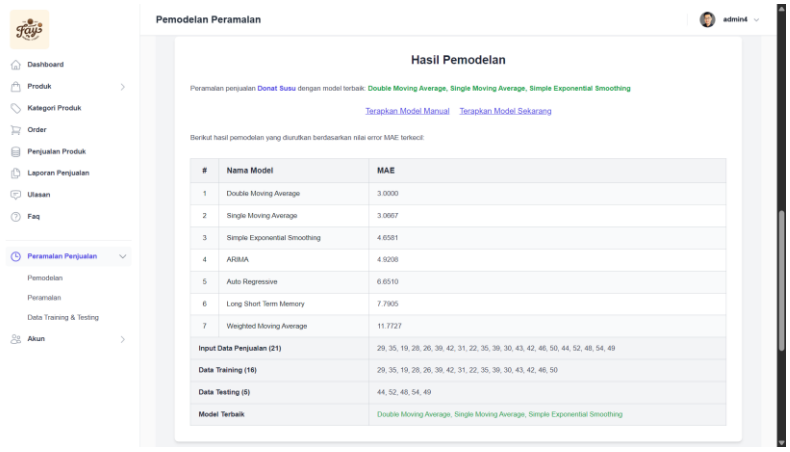
6. Admin Dashboard



Picture 6. Dashboard Admin

The admin dashboard serves as a centralized control panel for managing all business-related data, including product listings, categories, orders, sales reports, customer reviews, FAQs, sales forecasting, and user information. It supports efficient monitoring and management of daily operations.

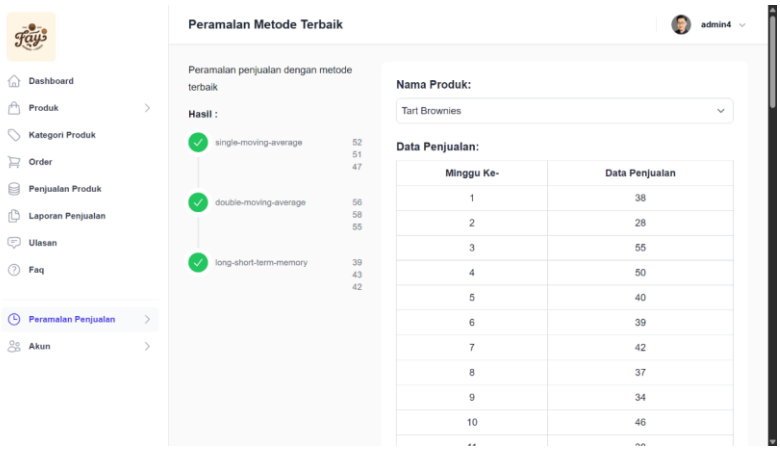
7. Forecasting Modeling



Picture 7. Forecasting Modelling

This module is used to determine the best forecasting model for each product. Historical sales data can be entered through an input form, and the system connects to the Django API to process and store the data for forecasting purposes.

8. Sales Forecasting



Picture 8. Sales Forecasting

This feature is used to predict future product sales based on historical data. The forecasting method applied corresponds to the best-performing model previously selected by the system during the modeling phase. As a result, only the most accurate forecasting method is used for each product. The forecast results are presented in both tabular and graphical formats, starting from the initial sales data period, allowing users to visualize trends and make informed decisions regarding production planning and inventory management.

3.2 Modeling Results

This section describes the forecasting modeling results for each product using the various methods discussed. The evaluation is based on the Mean Absolute Error (MAE) value as the main metric to measure the prediction error rate. The following are the modeling results presented in tables and graphs for each product.

Table 2. Modelling Results

Produk	Nilai MAE						
	Arima	SES	DMA	SMA	LSTM	AR	WMA
Kastangel	4.24	4.95	6.55	2.53	4.16	4.30	4.20
Lidah Kucing	6.37	7.21	10.05	6.40	5.64	7.38	6.64
Nastar	3.66	3.32	9.00	3.67	7.99	7.59	6.78
Putri Salju	4.07	4.56	2.80	2.93	10.34	3.36	13.56
Semprit	2.85	3.23	2.85	2.87	2.63	2.59	2.96
Palm Cookies	3.10	3.11	3.40	3.33	6.37	7.97	10.89
Donat Susu	4.92	4.66	3.00	3.07	7.92	6.65	11.77
Bomboloni	4.15	6.43	7.70	3.33	3.38	4.66	4.13
Tart Brownies	9.01	9.00	3.25	2.27	6.24	8.64	8.47
Brownies	2.73	2.21	5.70	2.27	2.09	3.51	2.44

Keripik Brownies	2.30	2.22	6.70	2.40	3.08	3.87	2.67
Pie Susu (Cokelat)	4.18	4.31	4.40	4.80	3.11	4.29	4.33
Pie Susu (Ori)	1.85	2.28	4.80	2.47	2.24	6.72	2.35
Bolen Cokelat	7.86	7.61	8.20	7.00	7.40	5.54	9.56
Bolen Keju	3.59	3.60	3.60	3.60	9.47	12.36	13.70

3.3 Forecasting Results

The following are the results of forecasting product sales data for the period from week 22 to week 24, presented in tabular form to illustrate the predicted trends. The data aims to provide insights into expected sales volumes for upcoming weeks based on previous historical patterns, which can assist in inventory planning, marketing strategies, and business decision-making.

Table 3. Forecasting Results

Produk	**22**	**23**	**24**
Kastangel	36	41	38
Lidah Kucing	41	35	33
Nastar	48	50	51
Putri Salju	64	65	61
Semprit	30	32	29
Palm Cookies	56	49	52
Donat Susu	49	46	47
Bomboloni	49	32	40
Tart Brownies	48	49	52
Brownies	36	34	41
Keripik Brownies	41	45	42
Pie Susu (Cokelat)	36	38	41
Pie Susu (Ori)	40	37	38
Bolen Cokelat	58	64	63
Bolen Keju	56	62	52

From the results of the sales forecasting, estimates can be made of the raw materials needed in the next sales period. Here are some of the raw materials used for each product per package:

Table 4. Product Raw Materials

Produk	Mentega	Tepung Terigu			Gula	Tepung Maizena	Telur
		Rendah	Sedang	Tinggi			
Kastangel	170	270	-	-	20	10	1
Lidah Kucing	175	-	200	-	100	20	4
Nastar	165	-	250	-	70	20	1
Putri Salju	175	-	250	-	50	50	1
Semprit	200	300		-	60	30	1
Palm Cookies	200	-	250	-	20	20	1
Donat Susu	30	-	-	250	35	-	1
Bomboloni	15	-	-	100	15	-	1
Tart Brownies	150	-	300	-	380	-	4
Brownies	50	-	100	-	135	-	2
Keripik Brownies	100			150	100		2
Pie Susu (Cokelat)	75		150		25		1
Pie Susu (Ori)	75		150		25		1
Bolen Cokelat	175	-	100	200	35	-	2
Bolen Keju	175	-	100	200	35	-	2

By knowing the amount of raw materials required for the production of each product and combining this with the results of the sales forecasting for the upcoming periods, it becomes possible to estimate the quantity of raw materials that will be needed in the near future. This estimation plays a crucial role in ensuring a smooth production process, avoiding stockouts or overstock situations, and optimizing procurement planning.

The forecasting results for product sales in weeks 22, 23, and 24 have been used as the basis for calculating the projected demand for raw materials during the same time period. These calculations take into account the bill of materials (BOM) or the standard usage of raw materials for each unit of product.The following table presents the estimated quantity of raw materials

required in weeks 22, 23, and 24, based on the projected sales volume and material consumption rates:

Table 5. Predicted Quantity of Raw Material Stock

Bahan Baku	Jumlah			Total
	Minggu 22	Minggu 23	Minggu 24	
Mentega	87,3kg	87,4kg	86,1kg	260.8 kg
Tepung Terigu Rendah	17,2kg	16,6kg	16,4kg	50.2 kg
Tepung Terigu Sedang	47,8kg	46,3kg	45,8kg	139.9 kg
Tepung Terigu Tinggi	69,2kg	67,1kg	65,9kg	202.2 kg
Tepung Maizena	5,5kg	5,3kg	5,1kg	15.9 kg
Gula	43,9kg	42,8kg	42,2kg	128.9 kg
Telur	912	897	882	2,691 butir

Based on the table above, it can be seen the prediction of the amount of raw material stock needed each week, this can be utilized as a good stock management step, so as to prevent excess or shortage of product raw materials significantly. This stock prediction also has an impact on the quality of the raw materials used, which are always fresh and up-to-date. Thus, the purpose of this research has been achieved as a success in predicting sales and raw materials in the next period.

CONCLUSION

Based on the research findings, it can be concluded that the development of a web-based online store application for Fay Brownies UMKM has successfully streamlined transaction processes and provided accurate sales predictions through the implementation of a forecasting system. The application has fulfilled user functional requirements, with all core features operating effectively, including the integration of forecasting methods such as ARIMA, SES, SMA, and LSTM. Evaluation results indicate that the forecasting models achieved a satisfactory level of accuracy, although slight deviations were observed in specific products namely Chocolate Milk Pie and Cheese Bolen during the third period. Overall, the system is effective in assisting business owners in planning production and managing raw material inventory more efficiently.

As part of business digitalization efforts, this system provides tangible benefits in enhancing competitiveness and reducing the risk of losses due to stock imbalances. This study also serves as a reference for the application of forecasting in e-commerce, which can be further developed for broader business scales or different product categories.

Several recommendations are proposed for future development: improving the accuracy of forecasting models using deep learning approaches, exploring variations in training and testing data proportions, employing more advanced imputation techniques to handle missing values, and enriching the application's features with AI capabilities such as chatbots, real-time analytics, and personalized product recommendations. Additionally, improvements in UI/UX design, enhanced data security through encryption and additional authentication layers, and the integration of digital marketing strategies such as social media and email marketing are suggested to expand market reach and improve user experience.

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