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Optimalisasi Manajemen Stok: Desain Sistem Inventaris Berbasis AI

Optimisation of Stock Management: Design of an AI-Driven Inventory System

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Abstrak

Industri makanan beku telah mengalami pertumbuhan yang luar biasa dalam beberapa tahun terakhir, didorong oleh meningkatnya urbanisasi dan permintaan akan makanan siap saji yang praktis. Meskipun tren peningkatan ini, banyak bisnis di sektor ini berjuang dengan manajemen stok yang tidak efisien, khususnya dalam memperkirakan permintaan harian karena perilaku konsumen yang berfluktuasi dan faktor eksternal yang tidak dapat diprediksi. Studi ini mengusulkan sistem perkiraan stok berbasis kecerdasan buatan menyeluruh yang ditujukan untuk mengoptimalkan manajemen inventaris untuk bisnis makanan beku. Dengan mengadopsi pendekatan Design Thinking, penelitian ini menempatkan pengguna—baik konsumen maupun pemangku kepentingan internal—di pusat proses pemecahan masalah untuk mengungkap titik-titik masalah operasional utama. Studi ini mengeksplorasi kemajuan teknologi terkini, termasuk augmented reality, RFID, dan blockchain, dan mengintegrasikannya ke dalam kerangka kerja praktis yang disesuaikan dengan usaha kecil dan menengah (UKM). Melalui analisis kualitatif dan pembuatan prototipe sistem, penelitian ini mengidentifikasi fitur-fitur penting untuk sistem manajemen stok yang cerdas dan menunjukkan bagaimana pendekatan yang berpusat pada pengguna dapat mendorong inovasi dan meningkatkan kinerja bisnis. Temuan ini menawarkan wawasan berharga tentang pengembangan solusi adaptif dan berbasis data di sektor makanan beku yang berkembang pesat..

Kata kunci— *Makanan Beku; Pemikiran Desain; Diagram Kasus Penggunaan*

Abstract

The frozen food industry has witnessed remarkable growth in recent years, driven by increasing urbanization and the demand for convenient, ready-to-eat meals. Despite this upward trend, many businesses in the sector struggle with inefficient stock management, particularly in forecasting daily demand due to fluctuating consumer behavior and unpredictable external factors. This study proposes an end-to-end artificial intelligence-based stock forecasting system aimed at optimizing inventory management for frozen food businesses. By adopting the Design Thinking approach, this research places users—both consumers and internal stakeholders—at

the center of the problem-solving process to uncover key operational pain points. The study explores recent technological advancements, including augmented reality, RFID, and blockchain, and integrates them into a practical framework tailored to small and medium enterprises (SMEs). Through qualitative analysis and system prototyping, the research identifies essential features for an intelligent stock management system and demonstrates how a user-centric approach can drive innovation and improve business performance. The findings offer valuable insights into the development of adaptive, data-driven solutions in the rapidly evolving frozen food sector.

Keywords— *Frozen Food; Design Thinking; Use Case Diagram*

1. INTRODUCTION

The frozen food industry has experienced rapid growth in recent years, particularly in urban areas where people have increasingly busy lifestyles and seek convenient food options. **Figure 1** shows that the global frozen food market was valued at approximately USD 193.74 billion in 2023 and is projected to grow at a compound annual growth rate (CAGR) of 5.4%, reaching around USD 278.47 billion by 2030 [1]. However, there is a major lack on stock management which is the owner cannot forecast daily demain because of multiple faced factor and nature [2].

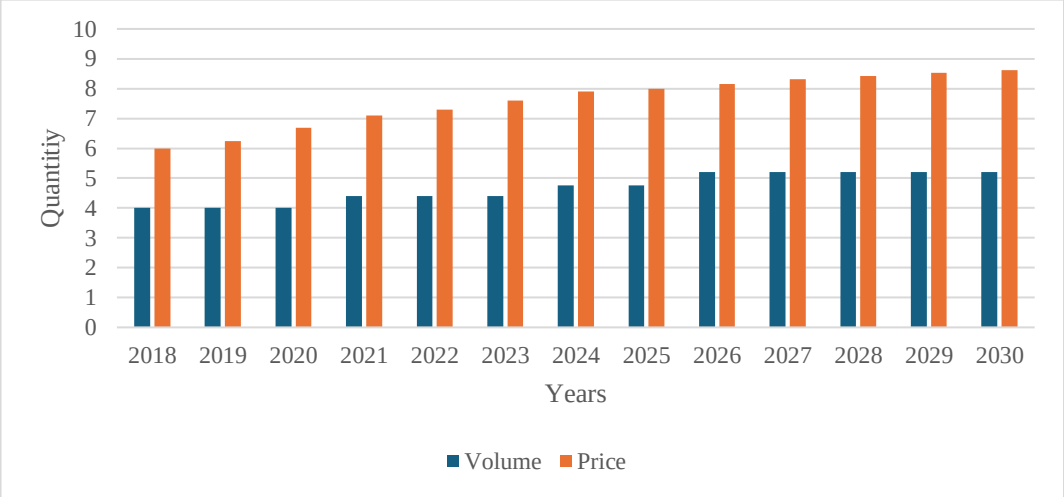

Figure 1. Frozen Food Demand and Price [1]

Most current research in stock management is focusing on make semi-integrated stock management. Napier and Lee [3] proposed Augmented reality and realtime object detection to help owner to differentiate a good product and bad product on fisinary. Kuo [4] and Ben-Daya, et al. [5]use of augmented reality and real-time object detection to improve product handling in inventory settings . Tan and Chang [6] proposed a RFID technology to support custumer centric e-restaurent. Sezer, et al. [7] proposed a blockchain architechture to make trusty stock management. Those proposed idea give better solution rether than non-used technology. Du, et al. [8] propose blockchain architectures to ensure transparency and trust in inventory transactions. Those proposed idea give better solution rether than non-used technology. The novely of This research is proposed end-to-end artificial intelligence stock management forcaster to predict daily stock.

To address these challenges, this research employs the Design Thinking approach, a user-centered methodology that enables businesses to analyze customer needs and create innovative solutions. The first step involves a thorough understanding of users—both consumers seeking

convenient food options and internal stakeholders managing business operations. By identifying core issues such as difficulties in accessing products, limited variety, and inefficiencies in inventory management, this study aims to develop an innovative system that enhances business performance. To achieve these objectives, the study aims to answer few research questions: (1)How design thinking approach can help business to understand and give solution?; (2)How can a proper system be designed to address the Stock Management?; (3) What are the essential features and functions required in an information system to optimize business performance? To answer those research questions, this research structured background research on chapter **Error! Reference source not found.**, used research method on chapter 0, research and discussion one chapter 0, and conclusion and Future Research on chapter **Error! Reference source not found.**.

2. RESEARCH METHODS

The design thinking (DT) approach allows to give potential solution to a problem by providing better service or product in productivity and operational. The DT need five phases: Empathise, Define, Ideate, Prototype, and Test. Design Thinking as a user-centered methodology for uncovering operational pain points [9].

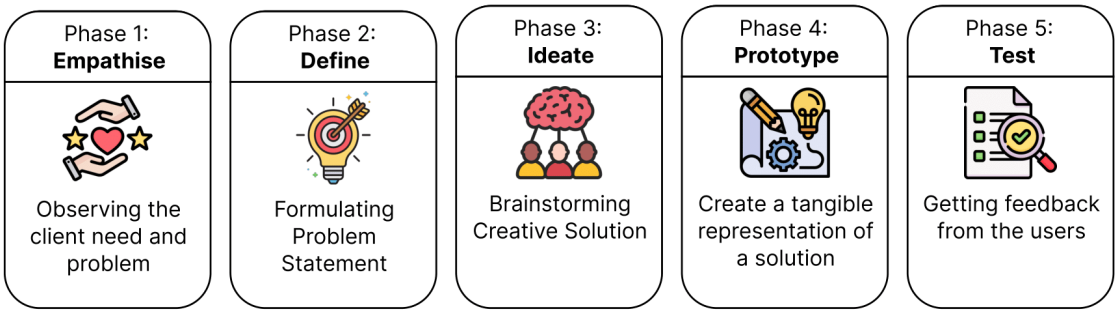

Figure 2. Design Thinking Approach for AI-Driven System Development.

2.1 Empathize

The Empathise stage tries to understand users' demands through in-depth conversations with business owner. This interview delves into the present business operational processes, such as product inventory management, business issues, and the utilisation of sales data to assist strategic decision making. In addition, this interview will delve into the owner's vision for business development, information system requirements, and features that are expected to boost operational efficiency and promote corporate growth. This interview should result in a thorough understanding of internal users' demands, which will then be summarised in the form of a business owner persona and a list of critical needs important to information system development.

2.1.1 Empathy Interview

The Empathy interview is used to observe subjective preception. This study mainly ask three questions:

i) What are the problems businesses faced when running business as retail on ? Are there any additional barriers that businesses have to overcome at the start?

iii) What problems do businesses face with selling products?

iv) What made businesses want to participate in upcycling? What can potentially be done to inspire other businesses?

2.1.2 Observation

The observation is necessary to complete information gethering. This research observe business process in 2 hour in business day. This research note processing time, idle time, task sequence, actor roles, and actor responsisbility.

2.2 Define, Ideate, and Prototype

After all necessary is obtainied, this research define, ideate, and prototype solution. We *define* the main problem using fish bone diagram. The fishbone is selected because fishbone can clearly show the main problem based on manpower, method, material, machine, and measurement. Then, we *ideate* solution according to fishbone. We used whiteboard to writedown all our group idea. We also discuss the short-term and long-term impact of the idea. Finally, a system prototype is created as an initial model to be tested by users. The initial action is to create a low-fidelity prototype, such as an application sketch, that briefly describes the system's design and functional flow. Furthermore, this prototype is upgraded to a high-fidelity prototype, which is an interactive simulation of the application's final appearance and function, allowing for more realistic user interaction testing.

2.3 Test

In the Test stage, the developed prototype is tested to confirm that the system meets the needs of the users. The primary activity at this stage is conducting trials with both internal and external users (customers). This study attempts to watch users engaging with the system in order to discover potential faults or areas for improvement. Furthermore, observations are conducted to gain input on features, functionality, and the overall user experience. Based on the feedback, the prototype is improved and iterated to better meet the demands of the users. The desired outcome is a prototype ready for further development, as well as validation that the solution created genuinely satisfies user expectations and needs.

Table 1. Test Interview Business

Individual Name	**Role**	**Business Function**
Bagus Prasetyo	Owner	• Overseeing production, inventory, and supply chain to ensure smooth operations. • Budgeting, pricing, tracking expenses, and ensuring profitability. • Collaborating with suppliers, distributors, and potential business partners. • Expanding the product line, improving quality, and adapting to market needs.
Mitiy Melinda	Cashier	• Handling cash, credit/debit card payments, digital payments, and issuing receipts. • Ensuring correct pricing, applying discounts, and giving accurate change. • Counting money, balancing cash drawers, and reporting discrepancies.
Dina Anugerah Putri	Cashier	• Noting low-stock items, scanning barcodes, and updating inventory records. • Preventing fraud, checking for counterfeit money, and following safety protocols.

Dika Pradana	Delivery Man	• Ensuring that frozen food products are delivered promptly to maintain quality. • Ensuring the delivery vehicle is in good condition for safe and efficient transport.

3. Results and Discussion

3.1 Business Description

This study select a business in urban city. The urban city is selected because we want to make sure the in-out product is complicated enough for big scale research. The detail business description is shown in Table 2.

Table 2. Business Description

Kinds	Description
Business Scale	Small
Industry	Food & Beverage (Frozen Food)
Business Model	Direct-to-Consumer (DTC), Retail, Delivery
Target Market	Students, working professionals, families
Location	Surabaya (Urban City)
Products Offered	Frozen meals, snacks, ready-to-cook items
Competitive Advantage	Limited competition, high demand for convenience
Key Business Functions	Marketing, sales, operations, customer service, logistics

3.2 Define

In this step, few important issues from business were found. The present stock management system does not operate in real time, making it difficult to effectively monitor product availability and avoid supply shortages. Product demand projections remain less precise, potentially resulting in surplus or shortages of inventories. The product distribution procedure has not been appropriately optimised, thereby increasing operational costs and slowing delivery times. Furthermore, existing marketing and analytics systems are still inadequate, preventing them from fully using sales data to uncover market trends or consumer preferences. Based on these challenges, the prepared problem statement will emphasise the need for an information system capable of managing stock in real time, accurately forecasting demand, optimising delivery routes, and providing more powerful analytical features to support marketing and decision making.

3.3 Ideate

The Ideate stage involves exploring innovative ideas in order to build solutions that suit the identified needs. Some of the concepts developed include an AI-based real-time stock management system that enables for accurate and automatic monitoring of product availability, as well as personalised product suggestions based on consumer purchase data to boost sales. In addition, sales trend and market demand prediction technologies are being developed to help with more timely stock planning and marketing strategies. To increase operational efficiency, a real-time traffic data-driven shipping route optimisation tool will be installed, allowing for faster and more cost-effective delivery. Furthermore, creating a user journey map ensures that all created features meet the needs and expectations of users, including internal management and customers. This stage yields a list of critical features that must be developed, as well as an early design of the system workflow that incorporates all of them.

3.3 System Requirement Analysis

An analysis of DS Frozen Food's business demands reveals that an effective information system is required to support numerous operational and strategic areas of the company. The system created must be capable of managing marketing and sales, such as using analytical tools to discover consumer preferences and optimise digital marketing efforts. With AI technology, the system will be able to make appropriate product recommendations based on purchasing data and consumer preferences, improving sales prospects and offering new products that are in line with market trends. Furthermore, AI will assist firms in predicting popular product trends, allowing them to modify product offerings more quickly. This information system must also monitor product inventory in real time to ensure adequate stock availability. With AI technology, the system can send out automatic notifications when product supply runs short and indicate how many things should be repurchased based on demand estimates. This will allow DS Frozen Food to minimise stock shortages and maintain seamless business operations. Furthermore, the system will automate transaction recording and generate precise sales data for financial analysis, allowing for more strategic decisions. To improve delivery management, this system will include an AI-based route optimisation tool that can compute the shortest route for product delivery to clients. By utilising real-time traffic data and other shipping parameters, the technology will help cut operational costs and ensure that products arrive on schedule for customers. Furthermore, the system will give an easily accessible interface to improve the client experience, allowing customers to order products online and receive delivery status updates. With an integrated system, DS Frozen Food can make faster and more accurate decisions, use data to build more successful product and marketing strategies, and promote business growth and sustainability in a competitive market.

3.4 Use Case Diagram

Use Case Diagram merupakan representasi visual dari interaksi antara pengguna (aktor) dan sistem, yang menggambarkan persyaratan fungsional sistem. Aktor utama meliputi Admin, Pelanggan, Driver dan Sistem AI.

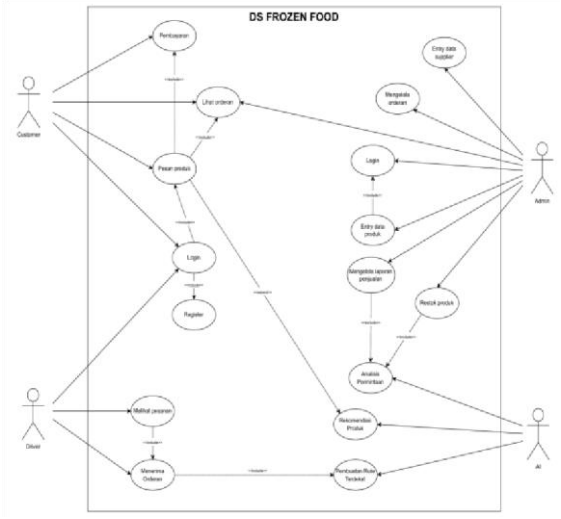

Figure 3. Use Case Diagram

3.5 Entity-Relationship Diagrams (ERD)

Entity-Relationship Diagrams (ERD) adalah representasi visual dari entitas dalam suatu

sistem dan hubungan di antara entitas tersebut.

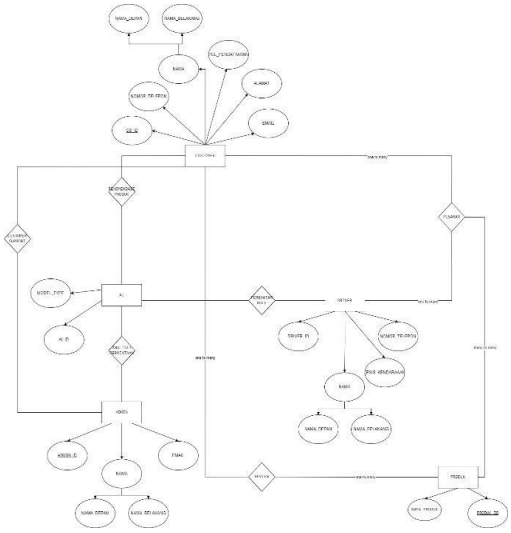

Figure 4. Entity-Relationship Diagram

3.6 Non-Functional Requirement

Table 3. Non-Functional Requirement

Non-Functional Requirement	AI should be able to calculate the closest route in less than 1 second after receiving location data.
Security	User data, login details and addresses, must be encrypted during storage and transmission.. The system must comply with data security standards for electronic payments, such as encryption for payment methods..
Design Constraints	The system must support integration with third-party APIs such as Google Maps API for route and location calculations.
Implementation	The system must support updating AI modules or databases without stopping application operations.
Interface	Web-based Admin Dashboard to monitor stock, transactions, and reports. User-friendly Mobile Application for customers and drivers.
	Integration with wearable devices for route notifications or reminders.
Physical	There are no specific limitations as the system is digital based without any major physical hardware.
Support	Online guides in the form of video tutorials and FAQs are available in the application.
	Application updates are carried out every 3 months or according to the need for new features.

3.7 Mockup

During the Mockup phase, the primary emphasis is on developing and evaluating a design prototype of the information system. This prototype seeks to present a preliminary overview of the system's functionality by illustrating the user interface (UI), process flow, and interactions among system components. This design prototype serves not only as a visual representation but also as a means to validate the conceived ideas. This assists the development team and business stakeholders in assessing and confirming that the proposed system aligns with the objectives and requirements of DS Frozen Food's operations prior to advancing to subsequent development phases.

Figure 5. Mockup

3.8 Testing

In this test, the User Acceptance Test (UAT) method is used, where users get the opportunity to try out the mockup of this application while answering the questionnaire questions that have been provided. The weight of the assessment of the questionnaire is presented in Figure 4.

Table 4 Questionnaire Assessment Weight and Percentage

Weight	Presentase	
1	0% - 20%	Not Good
2	21% - 40%	Less Good
3	41% - 60%	Enough
4	61% - 80%	Good
5	81% - 100%	Very good

Then there are 5 questions used for the questionnaire to support the User Acceptance Test (UAT) where 25 respondents filled it out. This is presented in table 5.

Table 5 Pertanyaan Kuisioner untuk *User Acceptence Test*

No	Questions
1	Content of information presented in the application mockup
2	Menu arrangement and menu content
3	Color selection in the application mockup
4	Ease of operation for users
5	Functions and interactivity in the mockup

After compiling questions for the questionnaire, the calculation of the results of the User Acceptance Test is carried out. The results of the User Acceptance Test are the results of the

respondents' filling in multiplied by the weight value in table 4. The results of the User Acceptance Test are presented in tabel 6.

Table 6 *User Acceptence Test*

No	Questions	Score					Total
		SB	B	C	K	SK	
1	Content of information presented in the application mockup	50	48	9	0	0	107
2	Menu arrangement and menu content	25	40	36	0	0	101
3	Color selection in the application mockup	25	40	30	0	0	95
4	Ease of operation for users	50	40	15	0	0	105
5	Functions and interactivity in the mockup	25	60	15	0	0	100

Then continued by calculating the average value by dividing the value from table 6 by the number of respondents. In addition, also calculating the percentage of each question to get a decent mockup quality by calculating the average value of each question then divided by the maximum weight. The results of the calculation are presented in tabel 7.

Table 7 Hasil rata - rata dan presentase dari pertanyaan UAT

No	Average Score	Presentase
1	4,28	86 %
2	4,04	81 %
3	3,8	76 %
4	4,2	84 %
5	4	80 %

In table 7, it can be analyzed that the percentage of question number one has a value of 86% and an average value of 4.28 indicating that the information content of the mockup is good. Furthermore, the percentage of question number two has a value of 81% and an average value of 4.04 indicating that the arrangement of the menu and content is neat and structured. Then the percentage of question number three has a value of 76% and an average value of 3.8 indicating that the color selection is sufficient and comfortable for users to see. Furthermore, the percentage of question number four has a value of 84% and an average value of 4.2 indicating that users are able to operate the mockup easily. Finally, the percentage of question number five has a value of 80% and an average value of 4 indicating that the function and interactivity are sufficient and run according to the use case that has been prepared [10]

4. Conclusion and Future Research

Frozen food stores are risky businesses because owners must meet customer needs and not waste stock. Frozen stores require stock management technology that can predict needs in real time. We have created use case diagrams, entity relationship diagrams, and non-functional requirements. We also ensure that our ideas are used and meet needs by using direct interviews with customers. This basic research is expected to be the foundation for similar research such as business intelligence research in frozen food.

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