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Design of a Warehouse Inventory Management System Using FEFO Method in NUSA Niaga Multi-Tenant

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Abstract

Most village-based businesses still manage their inventory manually, from monitoring warehouse stock and generating reports and checking items based on expiration dates. This process is considered inefficient and carries the risk of errors in data recording and reporting. In the process of transferring inventory to the display on the web-based NUSA Niaga platform, the FEFO method is applied. Needs analysis, system design, design implementation, and system documentation were conducted. Literature review on management systems, the FEFO method, multi-tenant architecture, and RBAC were used for data collection. The system was designed to monitor inventory, manage products nearing expiration, record goods transfers, and implement multi-tenant functionality using flowcharts, ERDs, and DFDs. This system is expected to help manage BUMDes warehouse in a more connected and structured manner.

Keywords: *BUMDes; FEFO; information system; multi-tenant; warehouse inventory*

1. Introduction

In village businesses managing inventory is still a very manual task. Every day warehouse staff have to count and check each item to see which ones are about to expire and which ones need to be moved to the shelves. All processes are still carried out manually without any technological assistance, draining time and energy while also being prone to mistakes or human error [1]. In addition, people's health may also be at risk if they buy products that are no longer suitable for consumption because of poor warehouse management. The frozen fish distribution industry is an example. The main reason stock isn't managed well is that the information systems used are separate and don't work well together [2].

For businesses, implementing the FEFO method is a sensible solution, as it requires that inventory nearing its expiration date be sold first. Several studies have proven that the FEFO method is capable of replacing slow manual record keeping and minimizing data discrepancies that often occur [3]. However, the implementation of FEFO cannot be optimal without the aid of technology. If there is no system to automatically monitor expiration dates, warehouse managers still have to check items manually, one by one [4]. This condition becomes a big challenge for inventory monitoring. To maintain a stable flow of goods, this method needs to be combined with the FIFO method [5]. Recent research shows that FEFO is now a key parameter in determining distribution policies for perishable food products [6].

With the shift from manual record keeping to a web-based system, data limitations can be resolved more optimally, human errors are reduced, and the reporting process becomes much faster [7]. In distribution companies, the design of web-based system can help improve data accuracy [8]. Not only that, direct inventory monitoring can be supported through the development of a web-based system [9]. Multi-tenant architecture allows multiple villages to use the same platform, for example Village A and Village B both use NUSA Niaga but each village's data remains separate, so Village A cannot see Village B's data, and vice versa. This concept is the foundation of NUSA Niaga's development, where each village can manage its warehouse data independently without worrying about being mixed with other villages' data [10]. This concept has been proven to be practically implemented in business management [11]. Therefore, data security needs to be designed from the very early stages of system planning, not added as an afterthought [12]. To ensure this, the use of Role-Based Access Control (RBAC) is a mandatory standard to limit each user's rights [13], [14].

Based on real cases, most village information systems that have emerged today still have very basic features and are not yet able to meet the specific needs of warehouse management[15], [16]. These increasingly advanced technologies actually hold great potential for handling complex operations, but their implementation rarely targets the retail sector at the village level specifically [17], [18]. In fact, previously developed retail inventory optimization models still have major gaps because they do not yet incorporate FEFO features or integrated multi-tenant systems [19].

Until now, no study has specifically applied the FEFO (First Expired First Out) method to the internal stock transfer process from warehouse to display within a multi-tenant platform for village-level businesses such as BUMDes. Previous studies have only applied FEFO at the final distribution stage, without exploring its application in internal warehouse-to-display transfer mechanisms [1], [3]. In response to this

gap, this study proposes the design of a web-based warehouse management system that applies the FEFO method for warehouse staff within a multi-tenant architecture, making it easier for warehouse staff to monitor stock nearing expiration, manage products that are running low, and can be used by other villages or BUMDes without worrying about data being mixed.le

2. Literature review

2.1. Inventory management

Inventory management is a process applied to products as a form of supervision and control over the storage, ordering, and use of goods within a business unit. Based on research, storing product in a warehouse for too long can trigger financial losses for business owners, and not only that, it can also endanger the health of consumers [1]. This is further supported by other researchers, stating that a good management system must be able to reduce slow recording, data loss, inconsistencies, and redundancy or double entries [3].

2.2. First expired first out (FEFO) method

The Expired First Out method is an inventory management approach that prioritizes product with the nearest expiration date for removal first. With technology capable of automatically monitoring products, this method is far more efficient than having warehouse managers check items one by one [4]. Research has been conducted to determine the optimal distribution of perishable goods using the FEFO method [6]. Based on real world cases, maintain a balanced flow of goods, the FEFO method is generally implemented alongside the FIFO (First In First Out) method [5].

2.3. Web-based information cystem

A web-based information system is applied because it is easily accessible anywhere and anytime using a browser. Based on research, a distribution company successfully improved data accuracy significantly [8]. By shifting from manual recording to a web-based system, human errors were minimized and the process became more efficient [7]. In this study, the web-based system makes it easier for warehouse managers to monitor products that are nearing expired.

2.4. Multi-tenant system

Multi-tenant is a single platform that can be used by many users while still keeping each user's data separate, for example user A and B both use the same web platform but user A cannot see the data of user B, and vice versa. The data is separated to prevent data accumulation and data leakage. Several researchers have proven that multi-tenant is very important. One of them, Fernandes Marques, proposed that the application of multi-tenant technology can be a good solution. Franclin and Hakim proved that multi-tenant applied in business management has been successfully implemented. This further strengthened by Camilleri, who stated that the protection and integrity of data between users is a crucial priority from the very beginning of system architecture design.

2.5. Role-based access control (RBAC)

Not every feature is intended for every user of a system. RBAC, Role-Based Access Control, is an answer to that. Each user can only use features that fit certainly does not need and should not be able to access the warehouse inventory page or sale reports, as that is not their concern. Fitrianto and Sulistyo note that with RBAC, each user's access is limited solely to features relevant to their responsibilities within the system. This view is also supported by Rizal Firmansyah et al., who state that in multi-tenant systems, RBAC becomes much more important because simply separating data not sufficient if there is no restriction on who is allowed to access what.

2.6. Entity-relationship diagram (ERD)

An Entity-Relationship Diagram (ERD) is a graphical notation used in the database design process to connect data elements. An ERD serves as a tool for designing database and provides an overview of how the database being designed will function. An ERD consists of three main elements, entities, attributes, and relationship [20].

2.7. Data flow diagram (DFD)

A Data Flow Diagram (DFD) is a graphical tool used to depict the flow of data within an information system. Specifically in system design, Data Flow Diagrams are used to visualize how data moves between various processes within the system. This approach supports the modeling of system functions by illustrating the processing, storage, and transmission of data between processes or system components [21].

3. Research methodology

This study focuses on designing a web-based system for warehouse managers using the FEFO method to transfer stock from the warehouse to the display within a single platform in NUSA Niaga.

3.1. Data collection method

In this study, data collection was conducted through a literature review. The literature review encompassed examination of various sources such as scientific journal and related references on inventory management, the FEFO method, multi-tenant architecture, web-based information system, and Role-Based Access Control (RBAC). This collected data served as the primary foundation for system design.

3.2. System design methodology

3.2.1. Need analysis

The system of the warehouse manager encompasses the core responsibilities of stock monitoring, expiry alerting, and warehouse-to-display transfer based on FEFO. The Super Admin system incorporates village data and user account management, allowing them to make decisions on who can access what. As the system is a web-based multi-tenant system, the warehouse manager and cashier are using the same system and never touch each other's data (each village data are well separated). Access control is also enhanced by implementing RBAC, which links the permissions of each user to the role they play in the system.

3.2.2. System design

In the design phase, this system has 3 main flows illustrated through flowcharts to describe the workflow of each user, especially the warehouse manager. DFD is used to describe the data flow within the system, while ERD is used to design the database structure.

4. Results and discussion

4.1. System overview

This system is used in BUMDes to support buying and selling transaction. In its operations, there is a role responsible for managing goods in the warehouse. The main features of the system include product transactions through a Point of Sale (POS) for the cashier, as well as warehouse management features that include stock monitoring, notifications for goods approaching their expiration date, and stock transfer

from the warehouse to the display using the FEFO method. This system is developed with a multi-tenant architecture, allowing it to be used by many villages simultaneously on a single platform while keeping each village's data separate.

4.2. System flowchart

4.2.1. Cashier flowchar

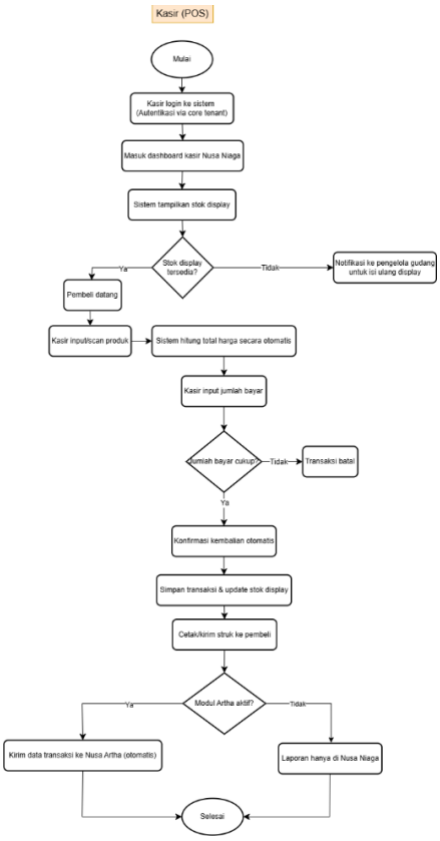

Fig.1: Flowchart Cashier

The flowchart in Fig. 1 illustrates the cashier's workflow in handling transactions, which includes scanning product, processing payments, printing receipts, and automatically updating the display stock.

4.2.2. Warehouse manager's flowchart

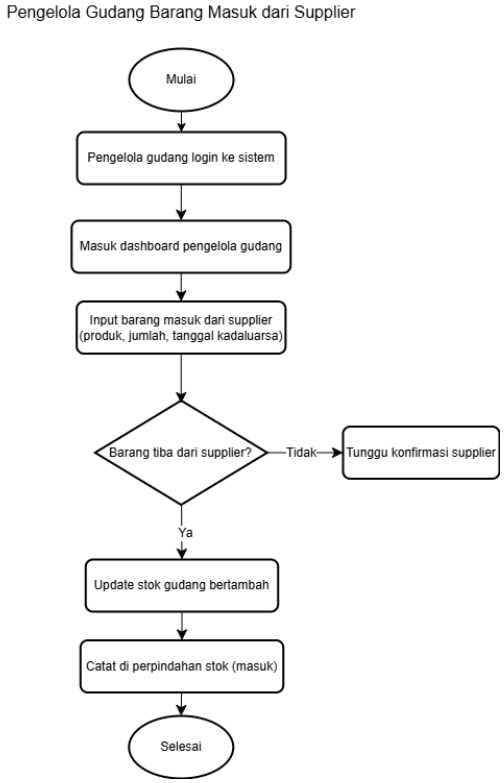

Fig.2: Flowchart Receiving from Supplier

The flowchart in Fig. 2 illustrates the workflow in receiving goods from suppliers, which includes inputting product data, quantity, and expiration date, confirming goods arrival, and automatically updating warehouse stock.

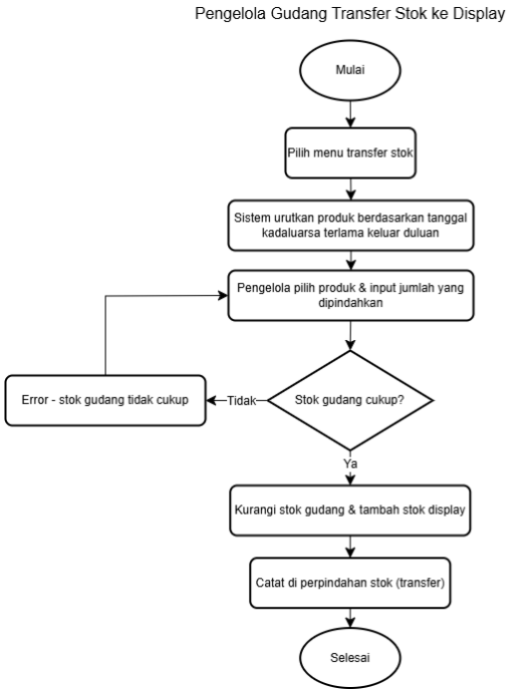

Fig. 3: Flowchart Transfer Stock

The flowchart in Fig. 3 illustrates the workflow in transferring stock from the warehouse to the display using the FEFO method, where the system automatically prioritizes products with the nearest expiration date to be transferred first.

4.3. Data flow diagram

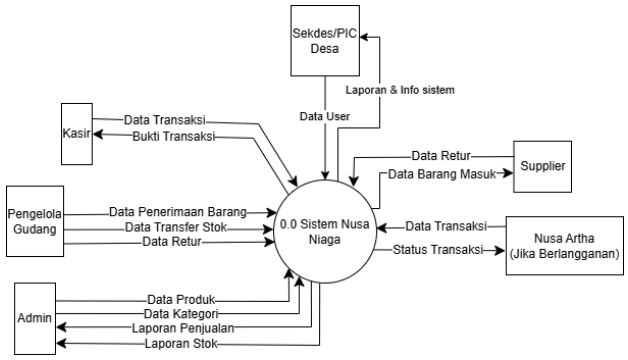

Fig. 4: Data Flow Diagram Level 0

Figure 4, which shows the DFD Level 0 which contains an overview of the NUSA Niaga system consisting of several actors, namely the cashier, warehouse manager, admin, supplier, village secretary, and NUSA Artha module, with several data flows such as sales transactions, stock management, goods receipt data, and sales reports.

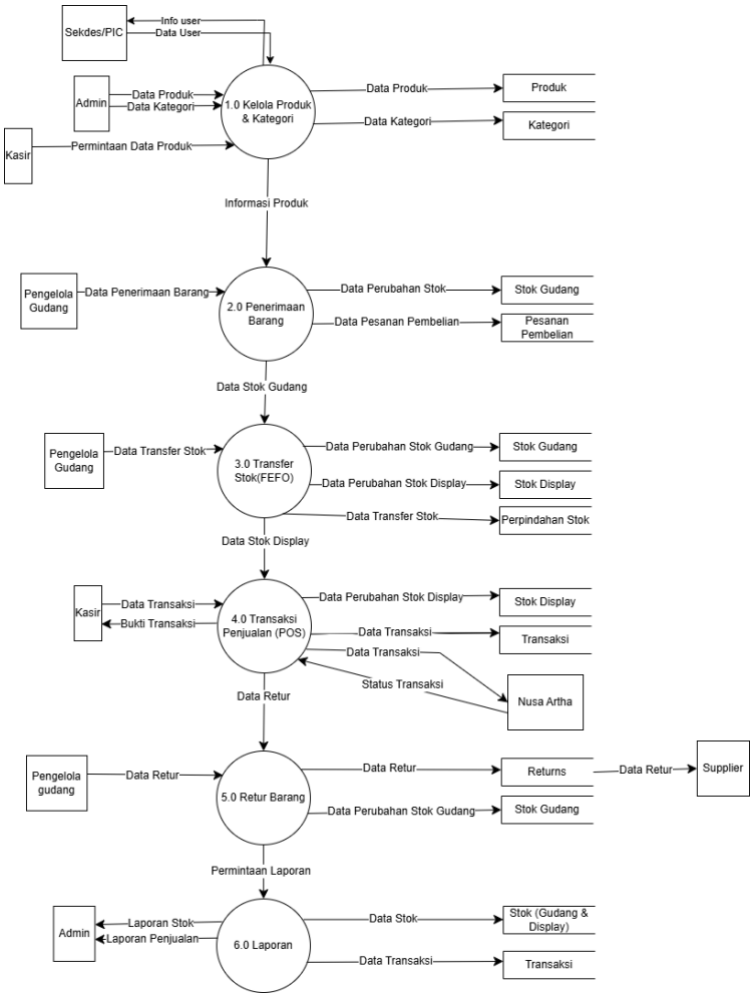

Fig.5: Data Flow Diagram Level 1

Fig. 5, which illustrates the Level 1 DFD, outlines the process flow within the NUSA Niaga system, including product and category management by the admin, goods receipt from supplier, stock transfer using the FEFO method by the warehouse manager, sales transactions through POS by the cashier, goods return, and report generation as the system's final output.

4.4. Entity-relationship diagram

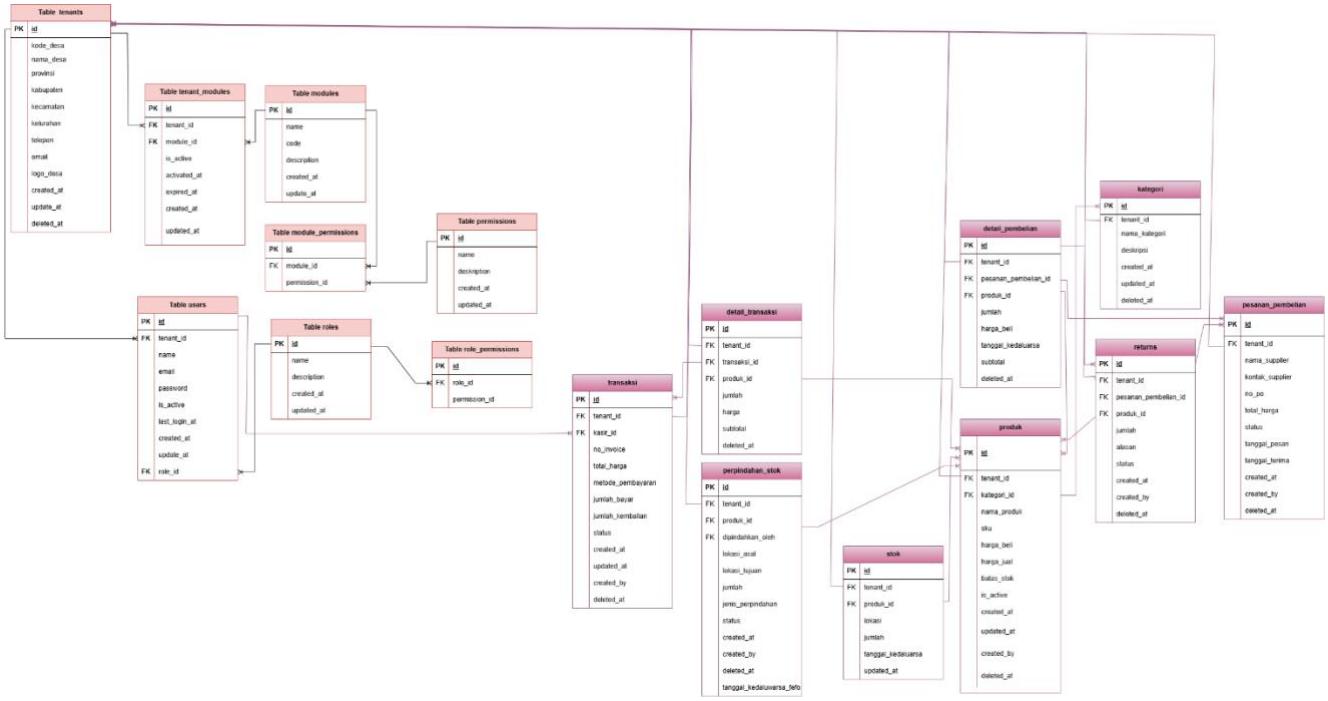

Fig.6: Entity Relationship Diagram

The Entity-Relationship Diagram (ERD) in Fig. 6 illustrates the database structure of the NUSA Niaga system, consisting of several main entities that are interconnected, such as tenants, users, products, stock, stock transfers, and transactions. This system also implements a multi-tenant approach through the tenants entity to ensure that each village's data remains separate within the same platform.

4.5. First expired first out implementation

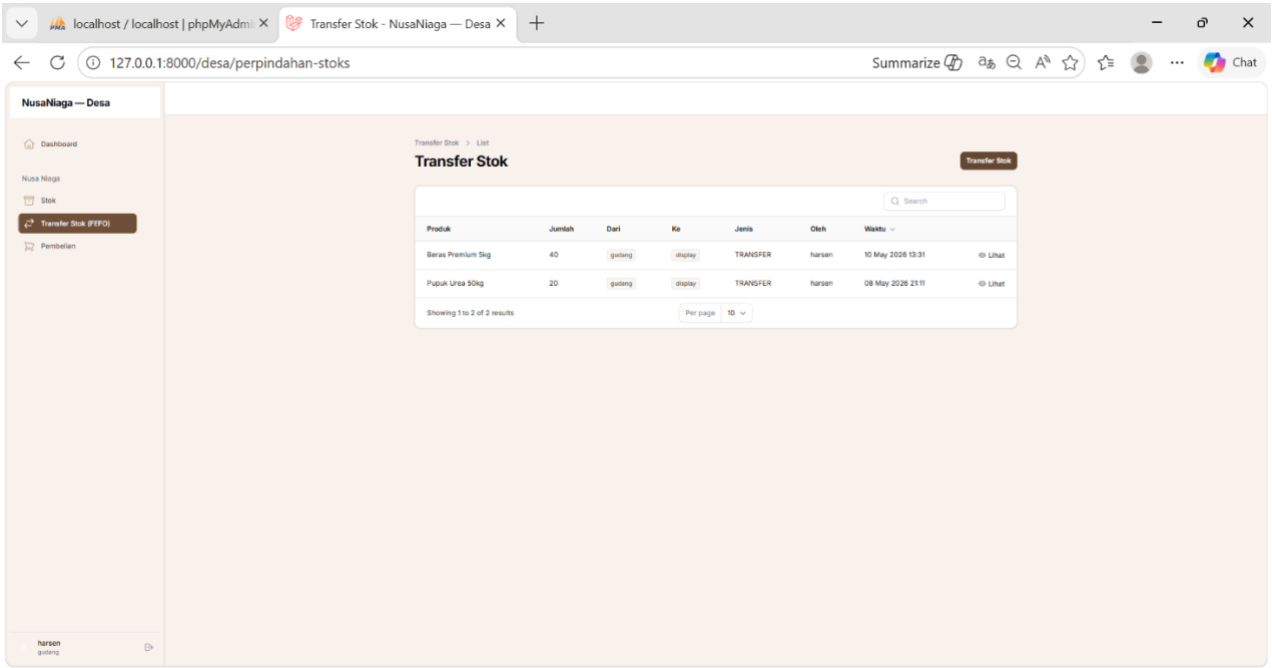

Fig.7: Warehouse Manager Transfer Stock Interface

The FEFO method is implemented in the stock transfer process from the warehouse to the display. When the warehouse manager accesses the stock transfer menu, the system automatically sorts and prioritizes products based on the nearest expiration date. As shown in Fig. 7, the system displays each product along with its current stock and expiration date, allowing the warehouse manager to select the quantity

to be transferred. Once the transfer is confirmed, the warehouse stock is automatically reduced and the display stock is increased, with the transaction recorded in the stock transfer log.

4.6. Multi-tenant system

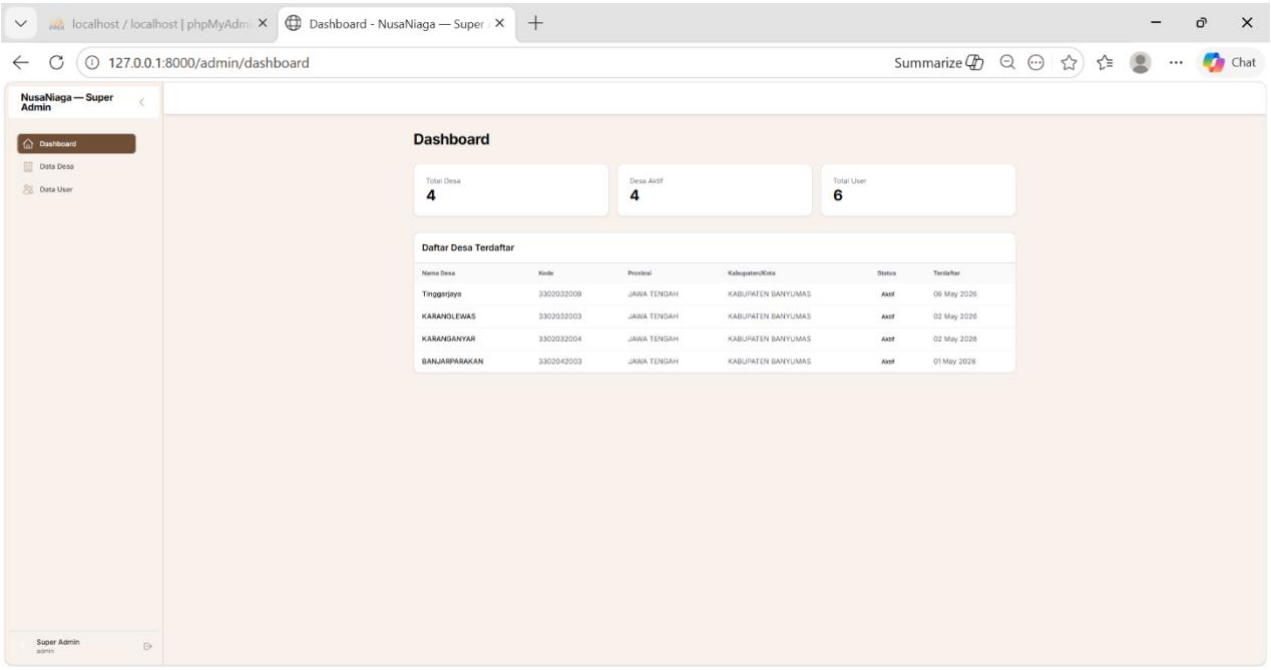

Fig.8: Dashboard Super Admin

The system is designed using a multi-tenant architecture that enables several villages to operate the NUSA Niaga platform at the same time. Data for each village is distinguished through the use of the 'tenant_id' attribute in every database table, which maintains data security and ensures that each village's information remains independent. As illustrated in Fig 8., the Super Admin has the authority to manage all registered villages through a centralized dashboard, whereas each village is restricted to accessing only its own warehouse and transaction records.

5. Conclusion

This study successfully in designing a web-based warehouse inventory management system with FEFO method in a multi-tenant architecture. The system created is expected to help warehouse managers in monitoring stocks that are about expire, managing stock transfers, and separating each village data in one platform. Future development can be focused on the full system implementation and addition more advanced inventory management features.

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