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Design and Development of a Data Warehouse for PT. CMS Using the Nine-Step Kimball Method

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Abstract: A fully automated and structured management system in today's era is very important to support more efficient use when making decisions in a company. PT Cipta Mulia Surabaya, a company involved in the construction, mechanical, and purchasing sectors, is also one of the companies that has a management system to manage company data. Since the establishment of this company, the management system used has not used technology that has been developed in the current era or the management system is still done semi-manually, so that it can cause less than optimal in making a decision or planning. To overcome this problem, researchers created an application entitled Data Warehouse Design and utilized the Nine Step Kimball method which consists of 9 (nine) stages. With this Data Warehouse Design and Construction, it is hoped that it can help management in decision making or simplify the planning process. In the process of creating this Data Warehouse Design and Construction system, the author uses a software that functions as a local server so that it can run an application that is being developed, the author himself uses XAMPP software as a local server, in addition to being a local server, XAMPP can also manage databases. While the software for the text editor, the author uses Visual Studio Code. It is expected that with this application system, the company's performance can be optimized.

Keywords: Data Warehouse; ETL; Kimball's Nine-Step.

1. Introduction

In the rapidly developing digital era, information technology has become an integral part of everyday life and the business world. An effective and efficient information system is a basic need for organizations to survive and compete amidst increasingly complex market dynamics. In this context, Data Warehouse design is one of the most relevant information technology solutions to support company performance to be more effective in strategic decision making [1]. Data Warehouse is a system that is able to extract, clean, adjust, and send data from various sources into dimensional data storage. The Data Warehouse system is specifically designed to support complex query and analysis processes without burdening the operational system that is running. Companies generally replicate data into the Data Warehouse system periodically, such as every night or weekend, from their operational systems such as human resources and sales databases. The data can then be processed through complex queries and analysis to obtain the information needed without disrupting the performance of the operational system [2]. Data Warehouse implementation is not only relevant for manufacturing companies, but is also very much needed by construction service companies that are currently facing fierce competition to maintain and develop their business. The increasing number of competitors requires construction service companies such as PT Cipta Mulia Surabaya to adopt more sophisticated information technology, including Data Warehouse, to support the company's operational and strategic activities [3].

PT Cipta Mulia Surabaya is a company engaged in the construction services sector. As one of the leading companies in the construction industry, PT Cipta Mulia Surabaya continues to adapt to technological developments and the latest trends in the construction industry. The company applies efficient modern methods and equipment, and integrates information technology into project management to increase productivity and optimize project supervision. However, behind this progress, the company still faces several significant challenges in data and information management. In its operations, when PT Cipta Mulia Surabaya successfully obtains a project through a tender process, the company often requires the services of freelancers as needed to work on the project. These workers can come from residents around the project area or be brought in from other cities. The problem faced by PT Cipta Mulia Surabaya is the absence of a recording system or recording of freelance workers who have participated in the company's projects, so that the process of searching for and recruiting freelancers becomes less effective. This shows the importance of implementing a structured information system for managing personnel data, as explained in Sihotang's research on scheduling information systems that can improve the operational efficiency of organizations [4][5]. In addition to the problem of recording freelance data, PT Cipta Mulia Surabaya also does not have a structured and well-organized company database or data storage. This condition causes the process of searching for data that is often needed for the tender process to be less effective and slow. Previous research by Harumy has shown that implementing an integrated information system can significantly improve the efficiency of managing personnel and operational data in a company. Without such a system, companies face obstacles in managing important information needed for accurate and fast decision making.

This suboptimal data management also has implications for the company's ability to conduct performance analysis, strategic planning, and data-based decision making. Hariyanto emphasized that an effective database management system is a crucial component in supporting modern business functions [2]. Without an integrated data storage and processing system, PT Cipta Mulia Surabaya faces difficulties in identifying trends, patterns, and business opportunities that can improve the company's competitiveness. In the context of information technology systems, Jogiyanto emphasized the importance of a systematic approach in data management to support various organizational functions. A structured information system allows companies to store, access, and analyze data efficiently, which is an important foundation for effective Data Warehouse implementation. Without this foundation, PT Cipta Mulia Surabaya will continue to face challenges in integrating and utilizing data from various sources to support strategic decision making. Based on the description of the problem, this study was conducted with a focus on data processing for PT Cipta Mulia Surabaya which is engaged in the construction services sector. This study takes the title "Designing PT CMS Data Warehouse Using the Kimball Nine Step Method". The selection of the Kimball Nine Step method is based on its advantages in providing a systematic and structured approach to Data Warehouse design.

2. Related Work

In today's digital era, understanding the fundamental concepts of data, information, and information systems is essential for effective organizational management and decision-making. This review synthesizes current literature on these interconnected domains, examining their roles in modern business environments and highlighting the technological frameworks that support data-driven decision-making processes.

2.1 Data and Information: Foundation Concepts

Data represents factual elements captured from the real world that can be recorded and stored in computer systems. The contemporary understanding of data has expanded significantly beyond traditional text and numerical values. As noted by researchers, modern databases now store document data, photographs, audio recordings, and video content. This evolution reflects the increasing complexity of information needs, where users can understand data as facts, text, graphics, sound, and video [2]. This expansion of data types has fundamentally changed how organizations collect, process, and utilize information for strategic purposes. Information emerges when data undergoes processing to create meaningful, actionable insights for recipients. The value of information is measured by its effectiveness relative to acquisition costs—truly valuable information delivers benefits that substantially outweigh the resources expended to obtain it. Information used in information systems typically serves various organizational purposes [3]. The transformation process converts raw data into useful content with specific meaning for recipients. This relationship establishes data as the fundamental source of information, creating a value chain where raw facts evolve into knowledge that can drive organizational decision-making.

2.2 Information Systems: Integrated Frameworks for Data Management

Information systems serve as extensive frameworks that assimilate related data elements into an organized structure dedicated to processing and distributing information. Multiple interconnected system elements work together to convert inputs into informational outputs which align with and support organizational goals. The fundamental components consist of input blocks which function as data acquisition mechanisms, output blocks which serve as information delivery channels, model blocks which handle processing algorithms, technology blocks which establish hardware and software infrastructure, control blocks which provide security and governance mechanisms, and database blocks which maintain structured repositories for data storage [4]. This integrated approach provides seamless data flow throughout organizational processes which supports operational and strategic needs. Today's information systems offer exceptional flexibility and expansion potential which allows organizations to adapt quickly to evolving business demands. Through advanced analytical capabilities these systems now provide enhanced decision support which includes sophisticated pattern recognition and predictive modeling features. Studies continuously demonstrate that organizations which adopt comprehensive information systems benefit from enhanced operational performance as well as better decision-making processes and improved market competitiveness.

2.3 Database Management Systems: Structured Approaches to Data Organization

A database represents a collection of information systematically stored on computer systems that can be accessed and queried using specialized software applications to retrieve information. The software typically employed for database querying is known as a database management system (DBMS) [5]. This systematic organization of data enables efficient storage and retrieval operations that would otherwise be impossible with unstructured data collections. Organizations can fulfill their information requirements by gathering dispersed data sets that maintain logical relationships within a unified database structure [6]. This consolidation approach eliminates redundancy while ensuring data consistency across different organizational functions and processes. A Database Management System (DBMS) functions as a cohesive framework that binds data elements together through specialized access programs. The resulting dataset, referred to as a database, contains original information stored systematically on computer systems. The primary purpose of DBMS technology is to facilitate straightforward storage and retrieval of database content. Database design focuses on processing various types of information data, which typically requires specific analytical procedures to support decision-making processes. Databases have become integral to daily life, with applications ranging from personal information management to student records, banking systems, and numerous other data-intensive domains [7].

2.4 Data Warehousing: Enterprise-Scale Data Integration and Analysis

A data warehouse represents a specialized system designed to support decision-making through various mechanisms including extraction, adjustment, cleansing, and transfer of data to storage repositories, subsequently supported and implemented through query and analysis functions. Organizations typically copy or extract data from their operational systems to populate these analytical environments [1]. This separation of analytical and operational data processing ensures that complex queries don't impact the performance of mission-critical transaction systems. Data warehouse characteristics differ significantly from conventional databases, with four distinctive attributes:

1) Subject Orientation
   Data warehouses organize information around business entities rather than specific operational processes, providing object-oriented information rather than focusing on business activities. These subjects may include distribution, sales, marketing, and other organizational functions.

2) Integrated Data Storage
   The integration within data warehouses establishes common measurement units for equivalent data from diverse database sources. This standardization ensures that data stored in the warehouse remains universally accessible to all users, eliminating inconsistencies that might exist in source systems.
3) Non-Volatile Data Storage
   Data warehouses maintain non-volatile properties, meaning that existing data remains intact when new data is added. The system supports regular updates while preserving historical records, facilitating historical analysis and maintaining detailed data records over time.
4) Time-Specific Data Collection
   Data warehouses encompass broader time horizons than transactional databases, collecting information from specific periods to provide comprehensive historical perspectives. This temporal dimension enables trend analysis and pattern recognition across extended timeframes.

The implementation of data warehouses delivers substantial benefits, including the ability to consolidate heterogeneous data sources into unified storage and transform unstructured data into homogeneous formats. This integration capability represents a primary advantage of data warehouse technology, enabling organizations to process diverse unstructured data into consistent formats with comprehensive information ranges [8]. Additional advantages of data warehouse implementation include enhanced data accessibility, improved data consistency, accelerated performance analysis, reproducible analytical results, identification of knowledge and process gaps, reduced administrative costs, and improved employee productivity through timely information access. Data warehouses exhibit diverse structural configurations with variations in data detail and chronological scope [9].

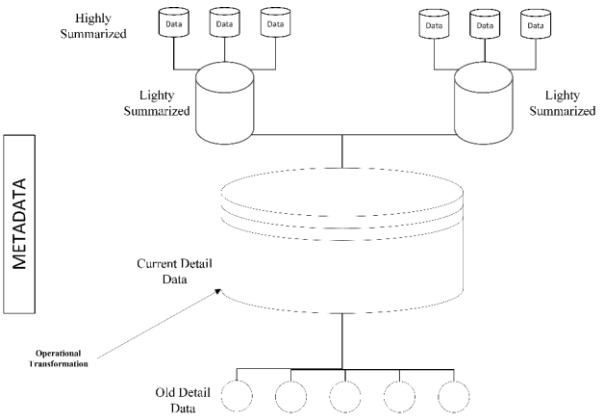

Figure 1. Data Warehouse Structure

The architectural components include:

1) Current Detail Data
   This represents active, current data at the lowest granularity level in the warehouse. Due to its unchanged state, this detailed information requires substantial storage capacity.
2) Historical Detail Data
   This consists of archived information stored on separate media for periodic retrieval, commonly referred to as historical data. Organizations typically use tape disks for this purpose, with data organization patterns reflecting chronological age.
3) Lightly Summarized Data
   This provides condensed summaries of detailed information without complete aggregation. This intermediate detail level satisfies departmental warehouse requirements and is commonly known as a "data mart."
4) Highly Summarized Data
   This represents fully processed, stable, and readily accessible summary information, typically used for multi-dimensional and time-ordered comparative analysis. The supporting multidimensional databases facilitate efficient table lookups and manage larger data volumes effectively.
5) Metadata
   Unlike operational data, metadata provides structural information essential for warehouse processes. Its functions include source data mapping for shared warehouse views, warehouse process management for automated production and summarization, and query management to direct inquiries to appropriate data sources.

The data warehouse architecture incorporates multiple functional components [10], forming what Poe describes as a structural framework for system design. This architecture establishes a foundation for identifying and understanding data movement through systems and organizational utilization patterns.

2.5 Extract, Transform, Load: Data Integration Processes

ETL represents a critical process in data warehouse implementations, facilitating the incorporation of operational data into analytical environments and enabling integration with existing systems [11][12]. The process consists of three distinct phases:

1) Extract
   This initial phase involves retrieving data from multiple sources, a common requirement in data warehouse projects that consolidate information from diverse systems. Since separate systems typically employ different data formats, extraction transforms source data into formats suitable for subsequent transformation processes.
2) Transform
   This intermediate stage involves data decomposition and warehouse loading. The transformation process encompasses multiple operations including column elimination, code interpretation, variable creation for value storage (*e.g.*, assigning "B" to "New" and "L" to "Old"), arithmetic calculations, multi-source data aggregation, row summarization, surrogate key generation, transposition between columns and rows, column segmentation, and data validation.
3) Load
   This final phase involves transferring processed data to the target environment, typically a data warehouse. The timing requirements vary according to organizational needs, with some warehouses supporting real-time detailed data loading while others implement weekly cumulative updates. The scheduling and scope of data replacement or augmentation depend on the warehouse design and specific information requirements.

2.6 Data Warehouse Design Methodology

Kimball proposed a nine-step methodology for data warehouse design, comprising: process selection, source identification, dimension identification and customization, fact selection, initial calculation storage in fact tables, dimension table review, database duration selection, dimension change tracking, and query priority and type determination [12]. This structured approach ensures that data warehouse implementations align with organizational requirements while maintaining design integrity and analytical effectiveness.

2.7 SQL Server: Relational Database Management

SQL Server represents a prominent Microsoft offering for relational database management, classified as a Relational Database Management System (RDBMS) [13]. This platform has achieved widespread adoption among leading global organizations, including those in Indonesia, representing a significant innovation in modern database technology. SQL Server delivers exceptional ease of use, performance, accuracy, and sophistication for managing small-scale modern database environments, making it an attractive option for organizations seeking reliable data management solutions. The integration of data, information systems, database management, and data warehousing technologies provides organizations with powerful capabilities for information management and decision support. As data volumes continue to expand and business requirements grow increasingly complex, these foundational technologies will remain essential components of effective information management strategies, enabling organizations to derive maximum value from their data assets while supporting both operational and strategic objectives.

3. Research Method

To develop an effective data warehouse system that meets the needs of the organization, this study applies various comprehensive data collection methodologies. Observation is a crucial initial step, where researchers observe the research object both directly and indirectly. The observation process is carried out over a certain period to obtain accurate data about the object being studied. After the data is collected, researchers record and store it to ensure that information is not lost and can be accessed again when needed in the analysis stage. In addition to observation, interviews are also an important method in collecting informational data. This method is commonly used in qualitative research, where respondents are asked to answer a series of questions with the aim of obtaining clear information from reliable sources. Interviews allow researchers to dig deeper and understand the organizational context that may not be revealed through observation methods alone. In this study, interviews were conducted with various stakeholders at PT Cipta Mulia Surabaya to understand the needs of the existing system and business processes. Literature study is the

third method applied, where researchers collect data from previous researchers who understand the theories written in books or other printed media, especially those related to the research subject. According to Danial and Warisah, literature study is a type of research conducted by collecting many books and magazines related to the subject and objectives of the research. This process includes collecting library data, recording, reading, and processing research materials [14]. Through literature study, researchers obtain a strong theoretical basis for data warehouse development and implementation of the Kimball Nine Step method [15].

In system analysis, this study focuses on Data Warehouse Design with the Kimball Nine Step method at PT Cipta Mulia Surabaya using MySQL as a means of storing data. The data that already exists in MySQL is then stored in a data warehouse and then a data cube is created using MySQL with the Kimball nine step method. This approach allows the integration of data from various sources and its transformation into a format that supports multidimensional analysis. The description of the system developed aims to facilitate employees at PT Cipta Mulia Surabaya in carrying out work that is still ineffective, such as the preparation of the Cost Budget Plan (RAB) in the tender process. RAB has a strategic role because it will determine the winner of the tender or auction of work. In addition, RAB also functions as a benchmark for work costs so that company owners or location managers can analyze the amount of budget that must be spent to avoid losses. With an integrated data warehouse system, the decision-making process related to budgeting and tender offers can be done faster and more accurately. To support system development, several hardware and software requirements have been identified. Hardware requirements include a CPU with a minimum 1.4 Ghz 64-bit Processor, a minimum of 4 GB RAM, and a minimum of 128 GB Hard Disk. Meanwhile, software requirements include the Microsoft Windows 10 operating system, MySQL Database Server, Integration Service with XAMPP Control Panel 2019, Visual Studio 1.89 2024 Text Editor, and Data Visualization using Tableau Public 2024. These specifications ensure that the system can run optimally and support all the required functionality.

In system design, a data flow diagram (DFD) is used to describe the system as a whole. DFD Level 0 is the highest description that shows the entire system being designed, while DFD Level 1 and Level 2 provide more specific details about the processes in the system. Entity Relationship Diagram (ERD) is also developed to describe the relationship between entities in the database.

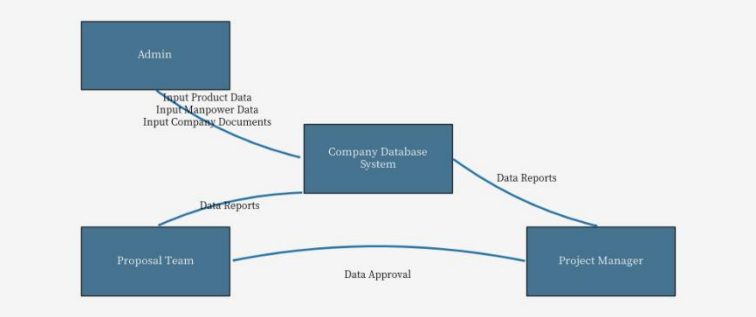

Figure 2. DFD Level 0

For database design, researchers use the Nine Step Kimball method which consists of nine stages. The first stage is process selection, where after evaluating the data used in the company, the business process used for research includes the data storage process, the process of collecting price data and its sources, and the process of submitting company documents. All divisions are involved in this data collection process. The second stage is source selection, which is assisted by the fact table. At this stage, the details of the data obtained from the dimensional model are also determined. The main data source is company data information which includes information on the price of goods, a list of workers, and company documents, with the HRD division as the party involved. The third stage is dimension identification and adjustment, where dimensions related to the fact table are identified. The three main dimensions identified are Dim_manpower (with attributes such as Id_manpower, photo_manpower, name_manpower, position_manpower, ktp_manpower, contact_manpower), Dim_product (with attributes such as Id_product, type_product, name_product, price_product, shop_product), and Dim_document (with attributes such as Id_document, Type_document, Name_document, Expiration_document). The fourth stage is fact selection, where the author chooses a table that is able to apply all the granularities used, namely product price list information. The selected fact table is a company data information table containing price information, worker data, and company document data. The fifth stage involves storing initial calculations in a fact table. At this stage, the data that has been collected will be processed through a calculation process to produce a fact table. This calculation process changes unstructured data into more relevant information. After that, the calculation results are temporarily stored in a storage system or database for further analysis, reporting, or processing. The sixth stage is to review the dimension table to add attributes and information. Each dimension is reviewed in detail with its attributes and data types, such as Dim_manpower with the attribute Id_manpower (Int(3)), photo_manpower

(Varchar(100)), name_manpower (Varchar(15)), position_manpower (Varchar(10)), ktp_manpower (Varchar(100)), and contact_manpower (Int(12)). The seventh stage is the selection of the database duration, where the data to be used covers the period of 1 year back. The eighth stage involves tracking dimensional changes, considering that the calculation value of the fact table always changes gradually according to market prices. The last stage is to decide on the priority of queries and types of queries, where physical design can be useful for providing the implemented data warehouse and for presenting report data.

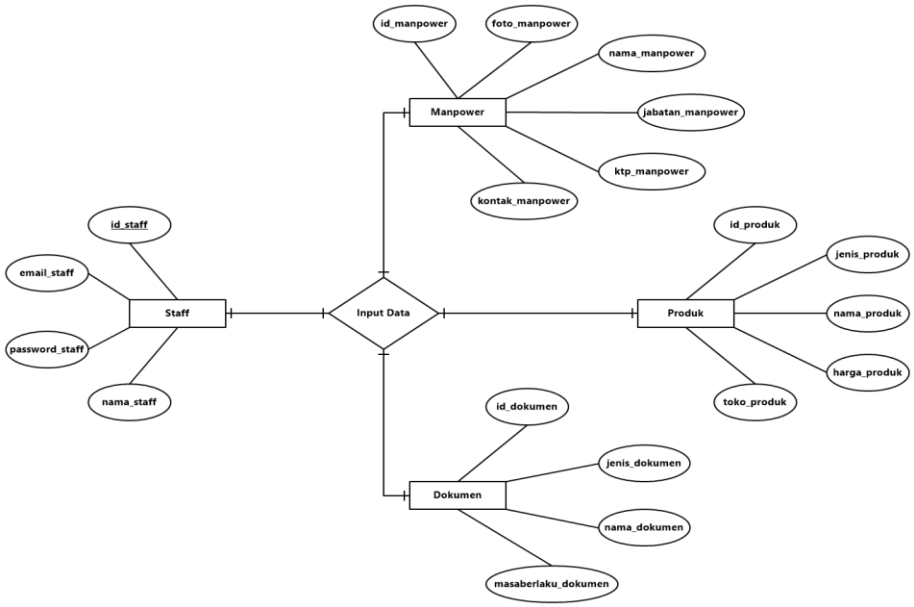

Figure 3. ERD

Through the application of a comprehensive research methodology and in-depth system analysis, the development of a data warehouse at PT Cipta Mulia Surabaya is expected to improve operational efficiency and support strategic decision making, especially in the process of preparing the RAB and tender offers.

4. Result and Discussion

4.1 Results

4.1.1 Database System

The database installation succeeded and it is accessible through http://localhost/phpmyadmin or http://127.0.0.1/phpmyadmin. This display represents the database which has been configured according to the earlier created DFD and ERD plans. The database structure functions to enable all features of the data warehouse system developed for PT Cipta Mulia Surabaya. This database contains four main tables which link together. The Document table holds company document data based on specific attributes including id_document, type_document, name_document, and expiration_document. The database table enables businesses to organize essential documents including certificates and legal permits. The Manpower table manages workforce information by storing essential attributes like id_manpower, photo_manpower, name_manpower, position_manpower, ktp_manpower, and contact_manpower. The table serves as an essential tool for human resources management because it streamlines the process for companies searching for employees affiliated with PT Cipta Mulia Surabaya. The Product table functions to store information about products based on attributes such as id_product, type_product, name_product, price_product, and shop_product. Price information required for preparing the RAB for tenders is centralized within this table. This table enables companies to both access and modify product price information needed for project execution. Company staff information gets stored in the Staff table based on requested attributes like id_staff and name_staff and other details including username and password. The table functions to manage system access by allowing only authorized users to access and edit system data.

4.1.2 ETL Script

This program's scripting combines the PHP programming language with SQL, HTML, and CSS programming languages. The author designed multiple files for this program which contains the Login page together with the Homepage, Administrator page as well as Input, Delete and Edit data pages. The author utilizes Visual Studio Code for scripting tasks while Bootstrap helps develop the framework to enhance both

the smoothness and attractiveness of the display. The data warehouse system relies on the Extract, Transform, and Load (ETL) process as a vital element. The author employs SQL language queries to perform efficient and structured data manipulation during the ETL process. The author adds data to the database through the SQL language INSERT command during the Extract process. The SQL command that adds data to the product table functions as follows:

```
INSERT INTO product
(product_type,product_name,product_price,product_store)
VALUES('$_POST[type]','$_POST[name]','$_POST[price]','$_POST[store]')
```

For the Transform process, the author uses the UPDATE command in SQL language which functions to change data in the database. An example of a data change command used in the product table is:

```
UPDATE product
type_product= '$_POST[type]',
product_name= '$_POST[name]',
price_product= '$_POST[price]',
shop_product= '$_POST[shop]'
WHERE id_product= '$_GET[id]'
```

Meanwhile, for the Load process, the author uses the DELETE command in the SQL language which functions to delete data in the database. An example of a delete data command used in the product table is:

```
DELETE FROM product WHERE id_product= '$_GET[id]'
```

The implementation of this ETL script allows the system to perform basic operations on data such as adding, updating, and deleting data in an efficient and structured manner..

4.1.3 View

The developed data warehouse system has several interface displays designed to make it easier for users to interact with the system. The Login display is the first page accessed by users, designed with a comfortable design, where staff entities can log in using this page. System security is guaranteed through this authentication process, ensuring that only authorized users can access the system. The Home display displays various types of products that have been inputted by admins or staff who have access to input data. In this display there is a filter or product filtering feature based on predetermined categories, so that it can make it easier for users to search for data based on categories. This feature is very useful in speeding up the process of searching for product price information needed in preparing the RAB.

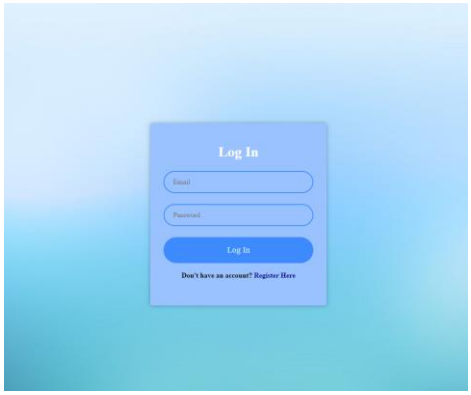

Figure 4. Login Page Display

Figure 5. Home Page Display

Admin View is the admin dashboard page that will display the username and several menus that have been designed for the Input, Delete, Update process according to the data to be changed. This dashboard is the control center for admins to manage all data in the system. The Product Dashboard view displays a list of products that have been inputted and there are several features such as Insert, Delete and Update. Through this dashboard, admins can easily manage product and price information used in the tender process.

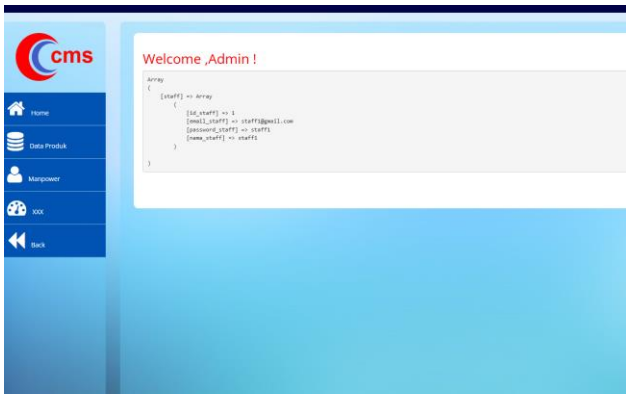

Figure 6. Admin Page View

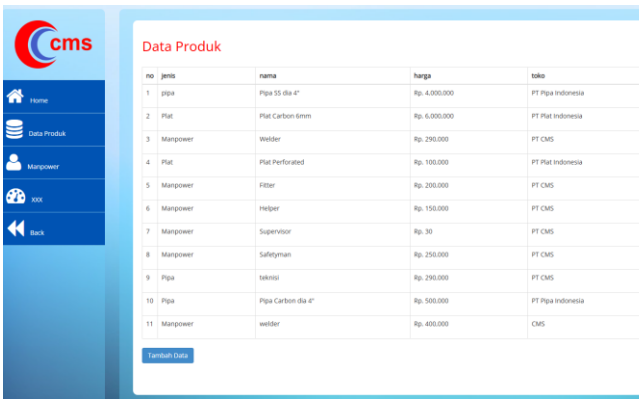

Figure 7. Product Dashboard View

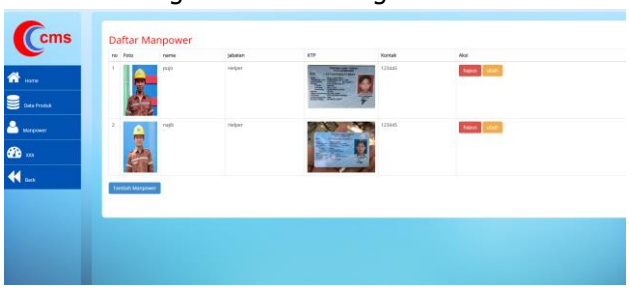

Figure 8. Manpower Dashboard Display

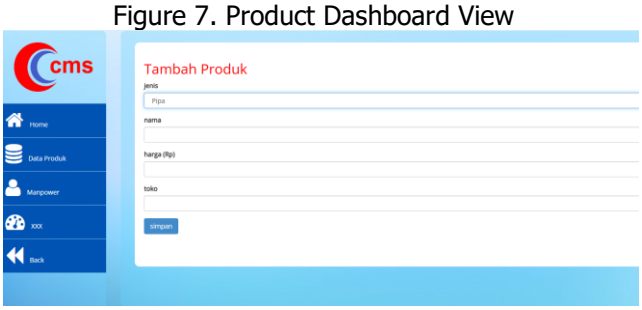

Figure 9. Data Input Process Display

The Manpower Dashboard display displays a list of manpower that has been entered and contains several features such as Insert, Delete and Update. This dashboard facilitates efficient and organized workforce data management. The Input Form display displays a form for product data input, which has four forms that can be filled in, namely type, name, price, store. The four forms will be stored in the database and can later be displayed on the Home display. The data input process is designed to be intuitive and easy to use.

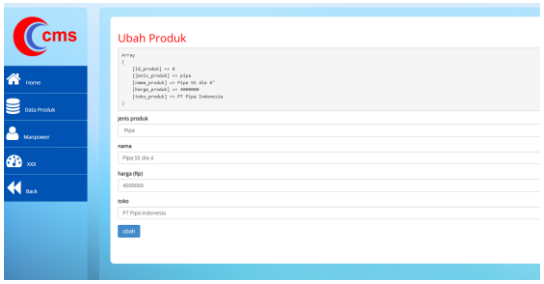

Figure 10. Display of Data Update Process

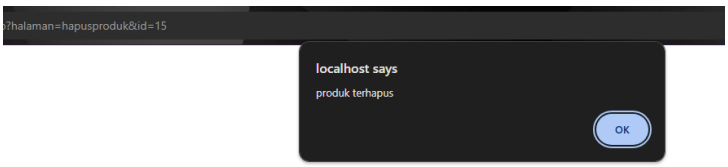

Figure 11. Display of Delete Data Process

The Update Form display is a display during the data update process or editing data that has been entered. On this form there are four forms, namely type, name, price, store. In addition to the four forms, this page also displays product data before it is changed or updated. This feature makes it easier for admins to track changes made to the data. The Delete Process display is a pop-up notification that the data has been successfully deleted by pressing the button labeled delete on the dashboard page. This feature provides confirmation to the user that the data deletion operation has been successful.

4.1.4 System Advantages and Limitations

The company performance can benefit positively from this system. Besides improving work efficiency this system stores all collected database data. The primary reason for developing this system was to enable the company to eliminate miscommunication among employees during the preparation of price documents required for tenders. The system helps to streamline the process of identifying employees who have joined PT Cipta Mulia Surabaya. The data warehouse system serves as an integrated platform that manages product details as well as workforce information and company documents which play crucial roles during the RAB preparation for tenders. By accessing well-organized data, location managers and company owners can perform precise budget analyses which helps decrease financial loss risk. The system enhances operational efficiency through faster access to necessary information. Staff members used to search through multiple separate sources to find necessary information but now they can access all required data through this integrated data warehouse platform.

However, this system also has several limitations. A major limitation includes the system's inability to update data in real time. Data warehouses typically operate on periodic data storage schedules such as daily or weekly which makes them incompatible with real-time data processing. Scheduled regular data updates by the assigned staff or administrator are necessary to prevent this deficiency. System scalability presents another potential challenge to users. The system will need more storage and processing power as the company expands and collects larger data volumes. Regular system performance monitoring and future capacity planning remain essential tasks. The advantages gained from deploying this data warehouse system outweigh its multiple limitations. PT Cipta Mulia Surabaya will enhance operational efficiency and RAB preparation accuracy through improved data management systems leading to faster information access which will strengthen their market position in bidding processes and minimize financial loss risks.

4.2 Discussion

The implementation of the data warehouse system at PT Cipta Mulia Surabaya has been successfully implemented with a comprehensive approach. This system is designed to support the company's business processes, especially in the preparation of the Cost Budget Plan (RAB) for tender purposes. The following discussion will examine important aspects of the results of the system implementation. The data warehouse system implemented at PT Cipta Mulia Surabaya shows a well-organized structure and is designed to support the company's operations. There are four main tables: Document, Manpower, Product, and Staff, which are integrated with each other. The integration of these tables is in accordance with the analysis of the company's needs that has been carried out using effective flowcharts (DFD) and entity relationship diagrams (ERD) [15]. This is important because a good data warehouse needs to accommodate relevant information in a structured manner to facilitate decision making [16]. An efficient table structure is very helpful in managing data quickly and accurately. The Document table stores information related to company documents, while the Manpower table manages data on the workforce, which is increasingly important in a business context that prioritizes operational effectiveness and efficiency [17][18]. In addition, data processing in this system follows best practices in the field of information management, with a focus on accuracy and accessibility of information for decision makers [15][19].

The Extract, Transform, and Load (ETL) process in this system is a key component that supports operational effectiveness. The implementation of ETL using SQL shows the right approach in data management. The Extract process uses the INSERT command to add new data, Transform uses the UPDATE command to modify existing data, and Load uses the DELETE command to delete unnecessary data, creating optimal conditions for maintaining data integrity [20]. Studies show that the use of effective ETL methods can minimize data integration errors, thereby ensuring better data quality [21]. Efficiency in the ETL process will encourage the data warehouse system to be more responsive to changing business demands, making this system very relevant in the context of modern companies that must be adaptive to market dynamics [22]. Studies also show that improvements in ETL techniques have a significant impact on the overall performance of data warehouse operations, with reduced resource usage and increased speed of information access [21][23]. Overall, the implementation of an integrated table structure and effective ETL process in the PT Cipta Mulia Surabaya data warehouse system provides a strong foundation for optimal information management, supporting timely and data-based decision making. Thus, this system becomes an essential tool in strengthening the competitive advantage of companies in increasingly complex markets [18][24].

The user interface of this data warehouse system is designed with ease of use and aesthetics in mind. The Login page provides secure access to the system, ensuring that only authorized users can access and modify data [15]. The Home page displays products with filter features that make it easy to search by category. The Admin Dashboard, Product Dashboard, and Manpower Dashboard provide full control over data management in the system [19]. The Input and Update forms are designed intuitively, making it easy to add and modify data. Notifications on the Delete process provide clear confirmation to users. This overall interface creates a positive user experience and supports operational efficiency [17]. The implementation of this data warehouse system provides a number of advantages for PT Cipta Mulia Surabaya. First, this system improves work efficiency by providing quick access to information needed in the process of preparing RAB for tenders [16]. Second, this system reduces the risk of miscommunication between employees in the process of creating price documents for tender requirements. Third, this system makes it easy to find information about workers who have joined the company. Fourth, with organized and easily accessible data, location managers and company owners can conduct more accurate budget analysis, reducing the risk of financial loss [21]

However, this system also has some limitations that need to be considered. The main limitation is in terms of real-time data updates. Data warehouses are generally designed to store data periodically, so they are not ideal for situations that require instant data updates [22]. To overcome this limitation, the responsible staff or admin needs to update the data regularly. In addition, as the company grows and the volume of data increases, the system may require increased storage and processing capacity in the future [24]. The implementation of a data warehouse system at PT Cipta Mulia Surabaya has shown success in creating an integrated solution for

managing company data [15]. This system not only improves operational efficiency but also supports better decision-making in the tender process [19]. With better data management and faster access to information, companies can increase their competitiveness in the industry and reduce the risk of financial loss [21][23]. For future system development, several aspects can be further improved. Integration with other systems in the company can expand the functionality of the data warehouse system [16]. The implementation of advanced analytical features can provide deeper insights into price trends and project performance. Mobile application development can improve system accessibility, allowing users to access important information even when in the field [24]. With continuous improvement, this data warehouse system will continue to provide added value for PT Cipta Mulia Surabaya in facing future business challenges.

5. Conclusion and Recommendations

Through the Nine-Step Kimball method implementation of this data warehouse project we accomplished the primary goal of establishing a central data repository that enables efficient process performance. The dimensional structure of this data warehouse integrates multiple data sources which enables effective data grouping and management to generate relevant information for PT Cipta Mulia Surabaya. Structured data loading from multiple sources into the data warehouse is enabled by the implemented ETL process which reduces data duplication and enhances loading accuracy. The system maintains continuous data consistency which ensures immediate readiness for analysis. When preparing a RAB for tender purposes precision in price information and resource availability proves essential because they are critical factors for decision-making. The core database architecture incorporates four fundamental tables (Document, Manpower, Product, and Staff) to efficiently meet the business demands of the company. Table integration enables users to directly obtain related data such as product-specific documents and skilled workers for designated projects. Management and staff benefit from the user interface's intuitive design because it simplifies data access and administration tasks. Product filters by category along with comprehensive dashboards enhance operational efficiency and minimize the time required to locate necessary information. As a result, productivity levels go up and decision-making becomes both quicker and better informed. The security settings control user access rights so that data remains protected from unauthorized users and available only to authorized parties. The login page authentication system grants system access exclusively to users who possess valid credentials, and the role-based access control system manages function permissions based on each user's assigned duties.

The data warehouse implementation has established a solid foundation for managing the company's data. The system boosts operational efficiency and enhances strategic decision-making capabilities. The structured data access system gives PT Cipta Mulia Surabaya an industrial edge because rapid and precise RAB preparation during the tender process ensures success. The foundation established through this implementation serves as a robust platform for future innovation and continuous improvement while the system requires additional development to enhance real-time data updates and capacity expansion as the company expands.

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