

Retail Data Visualization in Business Intelligence System for Ayu Nadi Group

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Abstract. Ayu Nadi is a company engaged in the daily needs retail industry. Ayu Nadi applies a computer-based information system in recording and managing data that produces operational information on company transactions, including sales reports, purchase reports, goods return reports, stock cards, etc. The report format was presented in tabular form, where data and information were presented in the form of tables. The resulting report could not display interactive information such as describing sales growth. The difference between item sales comparisons became the weaknesses of the report results. Thus, other applications were needed to reprocess tabulated data into information in the form of graphs. In this study, a website-based business intelligence system was built to assist companies in processing the tabulated data into information in graphs that did not require a long time. The research method used in this study was the nine steps Kimball method. The research was conducted through functional needs analysis, data warehouse design, extract transform load process, implementation of business intelligence, and system testing. This system was tested using the black box testing method and user acceptance test and has provided the results of the system was running as needed. The result of this study was a dashboard that showed information in the form of graphs to assist in decision-making.

Keywords: Business Intelligence; Data Warehouse; Power BI.

1 Introduction

Ayu Nadi is a company engaged in the daily necessities retail industry. Ayu Nadi applies a computer-based information system in recording and managing data. Until now, the company's database has recorded approximately 16,000 items with an average total transaction of 1,000 transactions per day. The implementation of this computer-based information system has been carried out since 2015. The system produces operational information on company transactions, including sales reports, purchase reports, goods return reports, stock cards, etc. The report format was presented in tabular form, where data and information were presented in the form of a table. The resulting report could not display interactive information such as describing sales growth, the difference between item sales comparisons, etc. became the weaknesses of the report results. In current conditions, the operational managers must reprocess the tabulated data in

other applications to produce information in sales growth charts, sales comparison charts with purchases, inventory charts, and so on. Given large data's size and growth, the reprocessing data outside the system certainly requires more time and effort. On the other hand, information is needed urgently in decision making.

In the recent era of technological advances and hyper-competition, business intelligence (BI) systems have attracted significant attention from executives and decision-makers due to their ability to provide complex and competitive information inputs for the decision process [1]. BI is a series of activities to comprehend business situations by conducting various types of analysis on data held by the organization as well as external data from the third parties to help determine the strategy, tactical and operational business decisions and take the necessary actions to improve business performance [2]. In higher education, BI can help us monitor and analyze the indicator data trends in an efficient and near real-time fashion [3]. BI also can be a solution to problems in processing and visualizing data into a more attractive and interactive graphic form. The application of business intelligence with Power Business Intelligent (Power BI) is expected to be a way to predict consumer consumption patterns [4]. In a hospital, reducing time and costs associated with certain tasks is a highlight, as it maximizes productivity [5].

This research developed retail data visualization using Power BI for Ayu Nadi. The data visualization displayed are seven display menus according to the needs of Ayu Nadi, namely sales, purchases, returns, bad stock, sales & purchases, sales & returns, and sales & bad stock menus. BI can enhance the dimensions of network learning and innovativeness. From this, a positive impact results in better performance behaviors [6]. The BI system built has two main processes, namely the construction of a data warehouse and data visualization with Power BI.

2 Methods

The research method used in this business intelligence system applied the method presented in **Figure 1**. **Figure 1** shows the steps starting from analyzing the system needs to be contained in Ayu Nadi Group. The next process is data warehouse design, where the process of designing a data warehouse follows the functional needs analysis. The method used to design the data warehouse is Kimball's nine steps. It consists of nine stages to build and develop a data warehouse. The steps for the nine steps Kimball are as follows [7]:

- 1) Choose the process. It was a stage to analyze the currently running process.
- 2) Choose the grain. This stage decided exactly what a fact table represents.
- 3) Identify and confirm the dimension. In this section, the dimensions of the previously created grains were determined.
- 4) Choose the fact. Once the grain and dimensions had been determined, a fact table was established.
- 5) Store pre-calculations in the fact table. In this process, the calculation was determined in the fact table, therefore, the measure can be found.
- 6) Round out the dimension table. This stage was an addition to the dimension determination stage. Here, the dimension table was equipped with attributes and descriptions.
- 7) Set up the duration. This stage determined the duration of the data used in the data warehouse.

- 8) Track slowly the changing dimension. This stage considered the dimensional changes, which can be slowly explored.
- 9) Decide the query. In deciding the query priorities and the query modes, this stage uses physical design to produce a data warehouse used for the data analysis process.

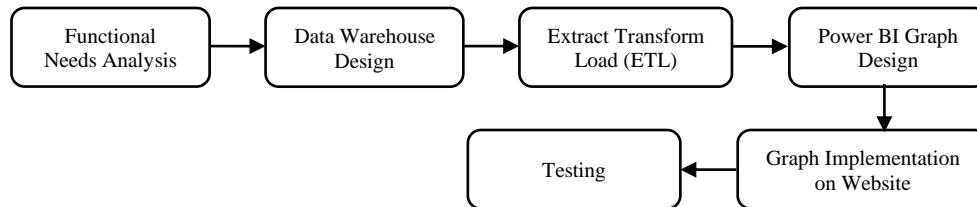


Fig. 1. Research method.

After designing the data warehouse, the next process is the extract transform load (ETL) process [8]. The ETL process is common terminology used in data warehouses that extract data from the source system, convert it according to business needs, and present it into a data warehouse. ETL extracts the data from various data sources and inserts it into a data warehouse. The ETL process is not a one-time process, but periodically/scheduled such as monthly, weekly, daily, even in hours [9]. After the ETL process, the next process is to create a graph on Power BI, which is converting the data obtained into a graph that suits the needs. Then the next process is the implementation of graphics on the website, which is the process of entering the graphics that have been completed on Power BI into the website that has been prepared. The last process is the testing process. In this study, two methods were used, namely the black box testing method [10] and the user acceptance test (UAT) method [11].

3 Results and discussion

There are 14 functional requirements from seven menus in the system that will be created in the functional needs analysis. The functional needs analysis, as follows:

- 1) The system can display monthly sales trends.
- 2) The system can display quarterly sales trends.
- 3) The system can display the top 10 and bottom 10 profits per item
- 4) The system can display the top 10 and bottom 10 percentages per item
- 5) The system can display monthly purchases trends.
- 6) The system can display quarterly purchases trends.
- 7) The system can display the top 10 suppliers.
- 8) The system can display monthly goods returns
- 9) The system can display quarterly goods returns.
- 10) The system can display bad monthly stocks.
- 11) The system can display bad quarterly stocks.
- 12) The system can display a comparison of sales and purchases
- 13) The system can display a comparison of sales and goods return.

14) The system can display the comparison of sales and bad stocks.

3.1 Data warehouse design

The first process of Kimball's nine steps was choosing the process. The business processes related to the needs used in this study are presented in Table 1. DWs enhanced business intelligence, data quality and consistency, saving time, and storing historical data [12].

Table 1. Choosing the process.

Business Process	Description
Sales Transaction	The process for storing all sales transactions
Purchase Transaction	The process for storing all purchase transactions
Goods Return	The process for storing all returns
Bad Stocks	The process for storing all bad stocks

After determining the business process, the next process was to choose the grain to determine the data warehouse fact table would present [13]. Following the functional needs obtained, the information displayed is presented in Table 2.

Table 2. Choose the grain.

Grain	Description
Monthly Sales	The number of sales can be viewed monthly
Quarterly Sales	The number of sales can be viewed quarterly
Top 10 and Bottom 10 Profits per Item	The number of profit per item by top 10 and bottom 10 profits
Top 10 and Bottom 10 Percentage per Item	The number of percentage per item by top 10 and bottom 10 percentage
Monthly Purchases	The number of purchases can be viewed monthly
Quarterly Purchases	The number of purchases can be viewed quarterly
Top 10 Suppliers	The number of suppliers by 10 suppliers that distribute most
Monthly Goods Return	The total of goods returned can be viewed monthly
Quarterly Goods Return	The number of goods return can be viewed quarterly
Monthly bad Stocks	Bad stock can be viewed monthly
Quarterly Bad Stock	Bad stock can be viewed by a quarter
Sales and Purchase	The comparison of sales & purchases
Sales and Goods Return	The comparison of sales & goods return
Sales & Bad Stock	The comparison of sales & bad stock

The next process was aimed to determine the dimension table. Based on the required data, the resulting dimension table is the Goods dimension which contains information about goods, the Branch dimension, which contains information about the branch, and the Supplier dimension, which contains information about suppliers. Furthermore, the following fact table is generated to meet the needs of Ayu Nadi, which can be seen in Table 3.

The next process is the process of storing pre-calculations in the fact table. In this study, the calculation result of the sales fact table was the number of sales which is the total sales rupiah. Also with another fact table were the number of purchases, goods return, and bad stock which is the total rupiah. After that, it was continued by completing the dimension table with attributes, types, and their respective descriptions.

Based on the results of the dimension tables and fact tables that have been created, the data warehouse schema was described to store the transaction data. There are three dimension tables and eight fact tables. The data warehouse schema used was the star schema.

Table 3. Fact table.

Fact	Information	Dimension
Sales of Goods	Contains information about the number and total sales of goods	Goods, Branch
Bill of Sale	Contains information about the amount and total sales on the transaction	Goods, Branch, Supplier
Purchase of goods	Contains information about the amount and total purchases on goods	Goods, Branch, Supplier
Purchase Note	Contains information about the amount and total purchases on the transaction	Goods, Branch, Supplier
Goods Return	Contains information about the number and total goods return on goods	Goods, Branch, Supplier
Goods Return Note	Contains information about the number and total goods return on the note	Goods, Branch, Supplier
Bad Stocks	Contains information about the number and total of bad stocks on goods	Goods, Branch, Supplier
Bad Stocks Note	Contains information about the number and total bad stocks on the note	Goods, Branch, Supplier

3.2 Extract transform load

There are several ETL processes, namely ETL goods dimension, ETL dimensions of branches, ETL dimensions of suppliers, ETL sale of goods facts, ETL bill of sale facts, ETL purchase of goods facts, ETL purchase note facts, ETL goods return facts, ETL goods return note facts, ETL bad stocks on goods facts, and ETL bad stocks note facts. This ETL process used the operational data of Ayu Nadi, which has been stored in the data warehouse using PostgreSQL and data that was still in CSV form. Then, the tools to perform this ETL process used Pentaho Data Integration.

ETL goods dimension is a process that begins with CSV File Input which is the process of inserting data in CSV form and then inserting it into the goods dimension table. The next process was the process of selecting data to be inserted into the goods dimension table. The ETL process for branch and supplier dimensions has the same process as the ETL process for these goods. The ETL process for the dimension of the good can be seen in **Figure 2**.



Fig. 2. ETL goods dimension.

ETL sales of goods facts is a process that begins with retrieving sales data from the operational database, and then the data cleansing process is carried out. Furthermore, if the data was null, then the value to be filled was zero. The next process was making the surrogate key, transforming the data that had been cleaned, and selecting the attributes to be inserted into the database. The last process was data loading to insert the data into the sales of goods facts. The other goods fact ETL process has the same process as well as the sales of goods fact ETL process. The ETL process for the sales of goods facts can be seen in **Figure 3**.

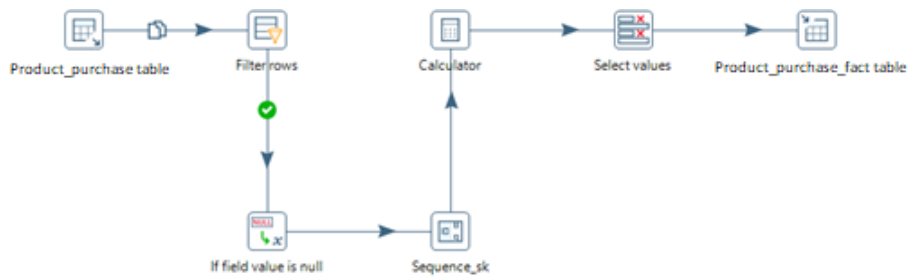


Fig. 3. ETL sales of goods facts.

ETL bill of sale facts is a process that begins with retrieving sales data from the operational database, then the process of making a surrogate key is carried out. The next process was the process of transforming the data that had been cleaned, then selecting the attributes to be inserted into the database. The last process was to load data to insert data into the bill of sale facts. The other ETL process of note facts has the same process as the ETL process of the bill of sale facts. The process of ETL bill of sale facts can be seen in **Figure 4**.



Fig. 4. ETL bill of sale facts.

3.3 Data visualization using power bi

The process of creating graphs used the help of Power BI tools. The data that has gone through the ETL process and stored in the data warehouse is then used in Power BI to generate a graph. There are 14 graphs displayed in this study, namely monthly sales trends, quarterly sales trends, top 10 and bottom 10 profits per item, top 10 and bottom 10 percentage per item, monthly purchases trends, quarterly purchases trends, top 10 suppliers, monthly goods return, quarterly goods return, bad monthly stocks, bad quarterly stock, a comparison of sales and purchases, a comparison of sales and goods return, and a comparison of sales and bad stock. The following is an example of graph making using Power BI in **Figure 5**. This tools applied some Indonesian terms, such as *Penjualan* 'sales', *Grafik Penjualan* 'sales chart', *Cabang* i'branch', *Tahun* 'year', *Tahun Penjualan* 'sales year', and *Bulan* 'month'.

The graphic that has been made was then implemented on the website. On the website pages, there were seven-page menus in accordance with the functional needs analysis that had been made, including sales, purchases, goods return, bad stocks, sales & purchases, sales & goods return, and sales & bad stocks. The implementation of Power BI Graph in the webpage is shown in **Figure 6**. Several Indonesian terms were used, such as *Return Barang* 'goods return', and *Pembelian* 'purchase.'

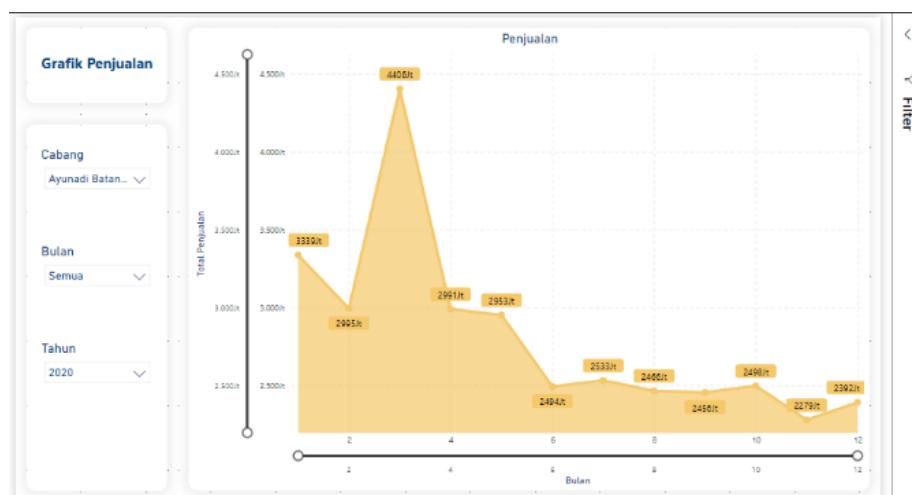


Fig. 5. Monthly sales graph.

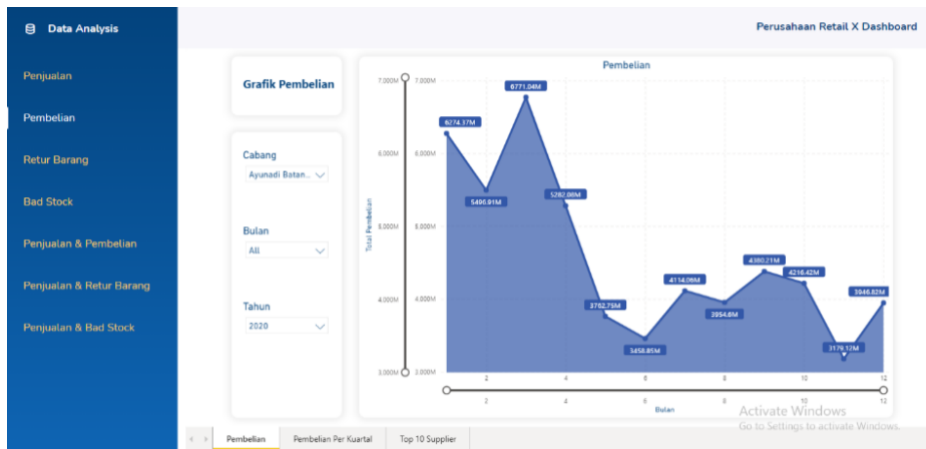


Fig. 6. Power bi graph implementation in purchases web page.

4 Testing

Testing was conducted to observe the implementation results through the test data and examine the function of system testing results. There were two tests in this system: a black box and a user acceptance test.

4.1 Black box testing

Black box testing is a type of testing that treats software with unknown internal performance [14]. Thus, the testers considered the software as a black box with unimportant content. However, it is sufficiently known the testing process in the external part [4]. The results of black-box testing are shown in Table 4.

Table 4. Black box testing.

No	Requirements	Results
1	The system can display monthly sales trends	Successful
2	The system can display quarterly sales trends	Successful
3	The system can display top 10 and bottom 10 profits per item	Successful
4	The system can display top 10 and bottom 10 percentage per item	Successful
5	The system can display monthly purchases trends.	Successful
6	The system can display quarterly purchases trends.	Successful
7	The system can display the top 10 suppliers.	Successful
8	The system can display monthly goods returns.	Successful
9	The system can display quarterly goods returns.	Successful
10	The system can display bad monthly stocks.	Successful
11	The system can display bad quarterly stocks.	Successful
12	The system can display a comparison of sales and purchases.	Successful
13	The system can display a comparison of sales and goods returns.	Successful
14	The system can display a comparison of sales and bad stocks.	Successful

4.2 User acceptance test

The User Acceptance Test (UAT) is a testing process by the user. It aims to produce documents used as evidence that the developed software had been accepted by the users [15]. The results of the user acceptance test are shown in Table 5 to Table 8.

Table 5. Results of the uat questionnaire for leaders.

No	Questionnaire	SA	A	LA	D	SD
1	Business intelligence system established according to needs	3	5			
2	Graphics of information displayed according to needs	4	4			
3	The graphics displayed can provide information clearly	5	2	1		
4	The display of the business intelligence system is clear and easy to understand	5	3			
	Total	17	14	1		

Table 6. Results of the uat questionnaire for staffs.

No	Questionnaire	SA	A	LA	D	SD
1	The data used in the graphing process is in accordance with the needs	1	1			
2	The data used in the graphing process is valid and there are no data errors		1	1		
	Total	1	2	1		

Table 7. Results of uat testing for leaders.

The Highest Score of UAT (f)	$\frac{\text{number of questionnaires} * \text{number of respondents} * \text{the highest score of questionnaires}}{4 * 8 * 5 = 160}$
Strongly Agree (SA)	$5 * 17 = 85$
Agree (A)	$4 * 14 = 56$
Less Agree (LA)	$3 * 1 = 3$
Disagree (D)	$2 * 0 = 0$
Strongly Disagree (SD)	$1 * 0 = 0$
Total	$85 + 56 + 3 + 0 + 0 = 144$
Percentage (Total / f * 100%)	$144 / 160 * 100\% = 90\%$

Table 8. Results of uat testing for staff.

The Highest Score of UAT (f)	$\frac{\text{number of questionnaires} * \text{number of respondents} * \text{the highest score of questionnaires}}{2 * 2 * 5 = 20}$
Strongly Agree (SA)	$5 * 1 = 5$
Agree (A)	$4 * 2 = 8$

The Highest Score of UAT (f)	number of questionnaires * number of respondents * the highest score of questionnaires
	$2 * 2 * 5 = 20$
Less Agree (LA)	$3 * 1 = 1$
Disagree (D)	$2 * 0 = 0$
Strongly Disagree (SD)	$1 * 0 = 0$
Total	$5 + 8 + 1 + 0 + 0 = 14$
Percentage (Total / f * 100%)	$14 / 20 * 100\% = 70\%$

The testing results were accepted when they met the user's needs. The UAT process was based on the document requirement mutually agreed upon. The document requirement is a document that contains the scope of software work that must be developed. Thus, this document should not be a reference for testing. This testing involved two actors consisting of eight branch leaders and two technical staff who were in charge of managing the company database, with a total of 10 respondents.

Based on the results of the User Acceptance Test (UAT) conducted at Ayu Nadi, the percentage table of UAT showed that the system established at Ayu Nadi received the assessment of strongly agree with the percentage of 90% for leaders testing. It received an assessment of agree with the percentage of 70% for staff testing. It means the business intelligence system was in accordance with the needs of Ayu Nadi.

5 Conclusion

According to the research results of the design of business intelligence systems in transaction analysis, it can be concluded that the Business Intelligence system had been successfully established based on the problems found in the research place. The researchers designed the system using Power BI tools and then, a database and data warehouse was created using PostgreSQL with Pentaho Data Integration. The Business Intelligence system was successfully established by having seven display menus. Those are sales, purchases, goods return, bad stocks, sales & purchases, sales & goods return, and sales & bad stocks. This system also had been tested using the black box testing method and user acceptance test that gave the results of the system running according to the company's needs. The UAT for the data visualization of assessment result showed strongly agree with the percentage of 90% for leaders testing and agree with the assessment with the percentage of 70% for staff testing.

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