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Pengembangan *Data Mart* Keuangan untuk Organisasi Nirlaba

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Abstract — **Keuangan merupakan komponen penting untuk keberlangsungan sebuah organisasi. Organisasi nirlaba harus memperhatikan kesehatan keuangannya sebagai bentuk pertanggungjawaban dana yang telah dipercayakan kepada organisasi oleh para pemangku kepentingan. Selain itu, organisasi juga harus bersiap untuk menghadapi risiko keuangan di masa depan. Sebagai organisasi nirlaba, SATUNAMA saat ini mengelola data keuangan secara terpisah untuk setiap sumber pendanaan. Hal ini mempersulit analisis keuangan dan pengambilan keputusan, terutama untuk memahami kesehatan keuangan secara holistik. *Data mart* keuangan dibangun untuk membantu analisis data serta sebagai tempat penyimpanan data historis berdasarkan serangkaian kriteria analisis yang telah ditentukan. Metode Kimball dan skema *starflake* digunakan dalam pembangunan *data mart* ini. *Data mart* berhasil diimplementasi berdasarkan desain skema dan telah memenuhi kriteria analisis yang diberikan. Selain itu, *data mart* juga berhasil memenuhi empat karakteristik *data warehouse* berdasarkan evaluasi karakteristik data. Berdasarkan evaluasi segi operasional, *data mart* terbukti lebih cepat dibandingkan dengan basis data operasional sehingga lebih efektif dalam memberikan informasi. *Dashboard* dan tabel pivot juga berhasil dibangun untuk memvisualisasikan hasil.**

Keywords— ***Data Mart; Kimball; Organisasi Nirlaba***

Development of Financial Data Mart for Nonprofit Organization

Abstract — **Finance is a critical component of organizational long-term viability. Non-profit organizations must pay close attention to their financial health. This is a form of accountability for funds entrusted to the organization by its stakeholders. Additionally, organizations must prepare for potential future financial risks. As a non-profit organization, SATUNAMA Foundation currently administers its financial data separately for each funding source. This complicates financial analysis and decision making, particularly when attempting to comprehend the organization's financial health holistically. A financial data mart was built in order to assist data analysis as well as store historical data based on a predetermined set of analysis criteria. The Kimball's method and the starflake schema were used in the development of this data mart. The data mart was successfully implemented in accordance with the schema design and was able to fulfil the given analysis criteria. The data mart has fulfilled the four characteristics of data warehouse based on the data characteristic evaluation. From the operational perspective evaluation, data**

mart is proven faster than operational database thus making the data mart more efficient in providing information. Dashboard and pivot table are also successfully built to visualize the results.

Keywords— ***Data Mart; Kimball; Non-Profit Organization***

I. INTRODUCTION

Digitalisation is the improvement of an entity through the use of information technology, computation, communication, and connectivity [1]. Digital transformation is essential for all industries, including non-profits, because it affects their ability to compete and survive in the digital age [2]. It is also necessary for innovation, particularly to improve their service, performance, and flexibility. SATUNAMA is a Yogyakarta-based non-profit organization engaged in community empowerment. With its expanding organization, digital transformation is necessary, particularly for its data organization. Even though a non-profit organization is not profit-driven [3], its finances must be organized professionally because they are responsible for managing funds from its benefactors. At SATUNAMA, the organization's financial transactions are managed by the finance department. Currently, SANGO, a non-profit finance application, is used to administer their financial reports. However, the existing financial data from each department is stored in a single database. This becomes especially difficult when a singular report is needed to assess the organization's financial health. In addition, its account numbers are not yet standardised and vary from year to year. This creates an additional obstacle when comparing financial data from multiple years, as account numbers must be manually adjusted. SATUNAMA must structure its financial data so that it can be used for analysis and decision making.

Non-profits frequently confront the challenge of data organization. Typically, this is often due to the limited resources non-profit organizations have for digital transformation [4]. According to a survey conducted by [5], many non-profit organisations do not allocate funds for technology, and many of their employees demonstrate a lack of dedication when it comes to managing technology-related matters. Even so, non-profit organisations recognise the importance of information technology, however they frequently have trouble finding affordable technological solutions [5]. Some technology needs in the non-profit sector include financial management, website, payroll, online giving tool, and customer relationship management [6]. Mobile, data, and cloud-based solutions are suggested by Boles [7] for non-profit sectors. In relation to data, Boles further added that the role of database could potentially aid in decision making by calculating input and output to support a more accurate donor report [7].

Several studies have been conducted to address the lack technology implementations in non-profit organizations. Chasanah dan Caesar [8], for example, created an information system to manage data on people with disabilities, volunteers, and activities at Yayasan PILAR. Their system is considered beneficial because it eliminates inconsistent data [8]. Jaya and Muanas [9] implemented an accounting information system for Yayasan Gibbon Indonesia in an attempt to increase the transparency of donor-provided funds. A similar solution was also carried out by Wibisono and Setyohadi [10], who developed an accounting information system based on the PSAK 45 standards. Their system contributed to the production of more accountable and precise financial reports.

Data management is particularly important as non-profit organizations must regularly report their activities to their donors. One way to do this is to have a centralised repository which can help organizations to gain insights into their own data and support data-driven decision making. National Health Insurace Administration (NHIA) in Taiwan, for instance, applied data mining techniques to gain insight to their large data set [11]. Specifically, they utilised data sorting and data association to analyse call centre data and implemented data visualisations to help support decision-making and enhance service quality and customer satisfaction [11].

One solution for consolidating data from multiple sources into a single repository is using data warehouse. A data repository can be useful for presenting accurate information about an organisation across multiple time periods [12]. Data warehouse implementation examples can be found in a variety of industries. In the education sector, data warehouse can be used to facilitate analysis, particularly for significant events such as accreditation. Filiana et al. [13] created an educational data warehouse to analyse community service and research data of lecturers for higher education accreditation. Data from multiple years and different sources were integrated into a centralised repository, which was then used for analysis and supported the reports used for accreditation purposes. Similarly to that of NHIA in Taiwan [11], a dashboard was developed to facilitate data visualisation [13]. Another example in the educational sector is the utilisation of data warehouse to analyse new students. [14] used nine step Kimball to create a data warehouse used specifically for data analysis of test results and final decisions regarding new students. The use of a data warehouse in this scenario is stated to aid decision-making for management [14].

Financial reports in non-profit organizations typically use large amounts of data and involve many departments. Processing significant amounts of data manually can be time-consuming, prone to error, and susceptible to loss, making analysis more difficult [15], [16]. Data warehouse can facilitate the processing of historical data. For instance, [17] created a financial data warehouse for a university using the Kimball method in the form of a star schema. Based on this data warehouse, they provided a web application where users can view visualizations regarding the university's financial information, such as transferred funds, obligations, and balance which was deemed beneficial [17]. Another case study is a data warehouse for a company's income and costs to answer the time-consuming process of data processing [18]. Data originating from different finance applications was consolidated into a data warehouse, and Microsoft Power BI was used to produce visualizations of the data warehouse [18].

The objective of this study is to develop a financial data mart that meets the requirements of SATUNAMA using the four-step Kimball design process. The data sources for this data mart will use data from SANGO, as well as Excel files generated over time by the Finance Department. A dashboard is also proposed to create data visualizations that can be read more easily by users. This solution will help SATUNAMA make better financial decisions for its organization, particularly in regard to its financial decision making.

II. Research Methods

Our research started with data collection and progressed via the four-step Kimball design process for data mart development, as depicted in Figure 1. The data collection phase includes both primary and secondary data sources. The primary sources were acquired by gathering existing business processes, firsthand observation, and interviews with the head of the Finance Department. The single databases produced by SANGO are analysed as well as other documents related to finance. Secondary sources included a review of literature on data warehouses, finance, and non-profit organisations from academic journals, books, and articles.

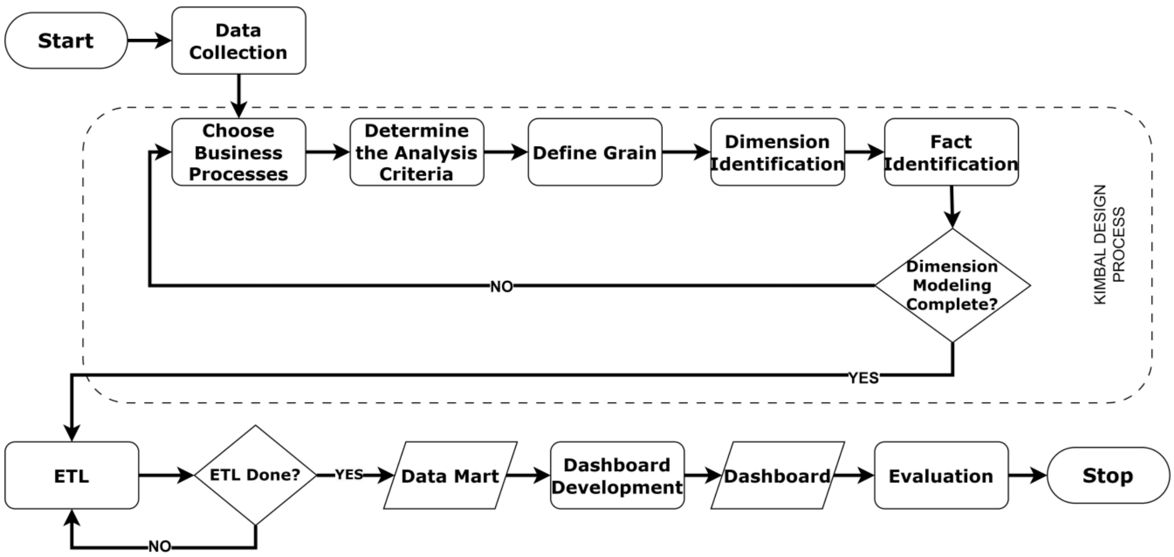

Figure 1. Flow Chart of Financial Data Mart Development

The Kimball method consists of four main steps. The initial phase includes the selection of business process. Since the Finance Department handles all of the organization's financial matters, the development of this data mart concentrated on transactions, account balance, internal budget realisation, and department productivity. At the end of this phase, together with the Finance Department, analysis criteria that will serve as the foundation for the development of the financial data mart are developed, as shown in Table 1. The second step of the Kimball method, the granularity of the data mart is defined. Granularity refers to the level of detail in the data mart [19]. Third, the dimensions of the data mart are defined. Dimension can be viewed as the perspectives used to analyse fact tables [20]. After establishing the granularity and dimensions of the data mart, the fact identification process begins [21]. Typically, fact tables contain measures in the form of quantitative data used for analysis [22]. In addition, fact tables also contain foreign keys that relate to its dimension tables [23]. At the conclusion of the Kimball method, we acquired a data mart schema that is ready to be implemented.

TABLE 1
ANALYSIS CRITERIA OF FINANCIAL DATA MART

No	Analysis Criteria
1.	Cash ratio
2.	Current ratio

No	Analysis Criteria
3.	Total debt ratio
4.	Income percentage
5.	Spending percentage
6.	Department productivity
7.	Comparison of funds from donors with internal funds
8.	Expenditures for current liabilities
9.	Expenditures for non-current liabilities
10.	Budget effectiveness

For the implementation stage, we used Pentaho Data Integration (PDI) to assist with the Extract, Transformation, and Load (ETL) process. Afterwards, Online Analytical Processing (OLAP) was utilised for analysis and to facilitate data analysis. The dashboard was built using Atoti, a Python library. This study employed a bottom-up approach. The financial data mart will be integrated with data marts from other units to form a final data warehouse. The system architecture of this data mart is shown in Figure 2.

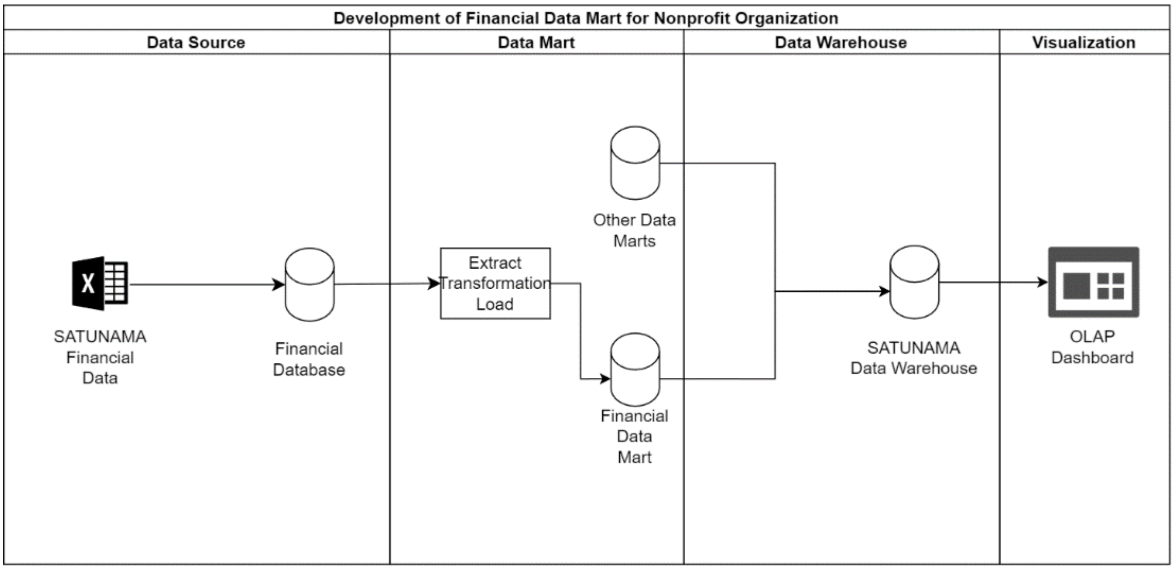

Figure 2. System Architecture of Financial Data Mart

The final data mart is evaluated based on the analysis criteria established at the start of this study. Using OLAP, the data was analysed from different perspectives. Furthermore, an OLAP dashboard was developed to make the analysis simpler for the Finance Department. Using the proposed evaluation from Esheta and Eldeen [24], the data mart is evaluated from two main aspects: data characteristics and operational perspectives. Both aspects ensure that the data mart is constructed in accordance with the standard. The data characteristics evaluation determines whether the data mart satisfies the data warehouse’s requirements, such as data reliability, integration, capability, and management. Additionally, the operational perspectives assess the usefulness and effectiveness of the ETL process and query performance. Specifically for query performance, the query response time between the data mart and operational database are compared with each other. The dashboard will also be assessed to ensure that the data displayed is accurate.

III. RESULT AND DISCUSSION

There are two main steps in this study: data mart implementation and OLAP dashboard implementation. The tools used in the implementation process are Pentaho Data Integration (PDI) for ETL and Jupyter Notebook for OLAP dashboard.

A. Data Mart Implementation

The data mart will be used to analysed four main business processes: transactions, account balance, internal budget realisation, and department productivity. From the business processes, we determine the grains that describe a single row in the fact table. We will use one row per transaction, one row per account balance, one row per internal budget plan, and one row per department productivity. One transaction row will contain debit and credit entries that are analysed based on time, funding source, account type, and project. Similar to transactions, one row per account balance will include debit, credit, beginning balance, and ending balance. Each metric will be analysed by year, account type, and funding source. In one row per internal budget plan, the total budget and budget realisation will be analysed based on time, funding source, and project. One row per department productivity contains three measures: debit, credit, and employee count. The measures will be analysed based on time and department. From the grain that we have determined, we defined the granularity as shown in Table 2.

TABLE 2
GRAIN SELECTION

Category	Granularity
Time Period	Month, Quarter, Year
Funding source	Unit, Department, Source of Fund
Account	Account, Account Group
Project Finance	Project Finance, Programme Finance

This data mart contains four primary dimensions: time, department funding source, account, and project finance dimensions (Table 3). These dimensions represent the analytical viewpoint of the financial data mart. Time dimension is used to view the data over a certain period. The department funding source is used to cluster the department funding source and which departments have transactions recorded in the data mart. Since the Chart of Account is used to group financial data, the account dimension helps SATUNAMA see their financial situations based on how different types of funds are used. NPO focuses on programmes and projects thus the project finance dimension is used to see the use of funds for each programme and projects. Due to the fact that each year has unique account numbers, the account dimension will be related to the time dimension.

TABLE 3
DIMENSIONS

Dimension	Attributes
Time Dimension	Date, month, quarter, semester, year, day in month, day in week, month name, month name short, day name, day name short, and day in year.
Department Funding Source Dimension	Department code, department name, unit name, source of fund name
Account Dimension	Account code, account name, categorization
Finance Project Dimension	Finance programme name, finance project name, finance project code

In this study, we identified four primary fact tables. The first fact table focuses on which will be used to analyse financial ratios such as cash ratio, current ratio, and debt ratio. This fact table will also be related to the following dimension tables: department funding source, account, time, and project. The second fact table, internal transactions fact, will be used to analyse both incoming and outgoing funds, as well as budget and realisation of funds. This analysis can be seen from several dimensions including time, project finance, and department funding source dimension tables. The third fact table focuses on the productivity of departments. This fact table will contain debit, credit, employee count, as well as foreign keys connected to time and department source of funds dimension tables. Lastly, the internal budget fact is used to analyse budget total and budget realization which can be viewed from multiple dimensions, including time, project finance, and department funding source. The final data mart schema can be seen in Figure 3 using the starflake schema, a combination of star and snowflake schemas that has the advantage of both schemas. With star schema, it is easier and more efficient for the organization to access the data. Additionally, starflake schema is more adaptable to an organization’s requirements [25].

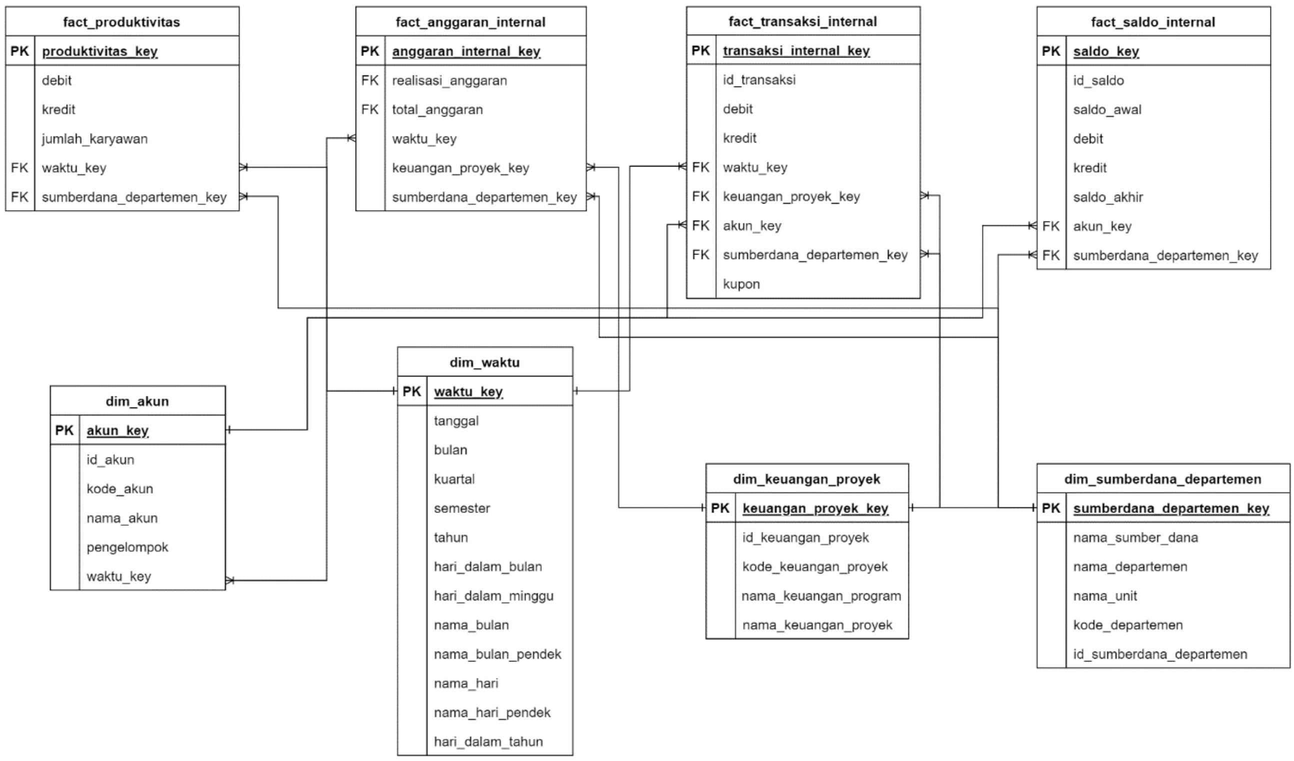

Figure 3. Data Mart Schema for the Finance Department of SATUNAMA

Based on the final schema, we began constructing a total of six-dimension tables and four fact tables in PostgreSQL. Then, the ETL process is employed. Figure 4 shows the ETL process for dim_waktu (time dimension). This dimension is a crucial component because it forms the basis of the data warehouse. The time dimension was generated by evaluating and generating all dates since the inception of SATUNAMA. As shown in Figure 4, the process included generating all the dates from the date of inception, extracting the time attributes (date, year, quarter, semester, month, day in month, day in week, month name, month name short, day name, day name short, and day in year), and finally storing it into the time dimension table. The time dimension will be used in conjunction with other data marts.

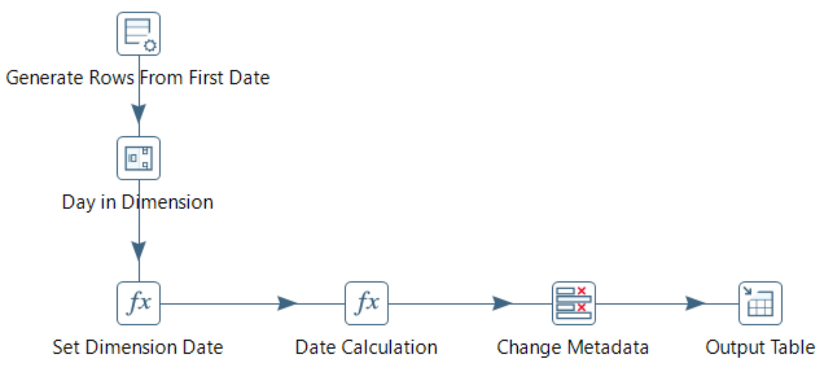

Figure 4. ETL of time dimension

After the time dimension was generated, other dimension tables were processed. The four dimension tables, dim_keuangan_proyek (dimension table for project finance), dim_akun (account dimension), and dim_sumberdana_departemen (department source of fund dimension), follow to a similar ETL process pattern, which commences with data retrieval from the source and continues with a lookup operation to the time dimension. This lookup

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procedure is necessary to check that the date is within the agreed-upon time range specified in the time dimension, as well as to acquire the time ID, which will be particularly essential for extracting the time attributes. Afterwards, data were loaded into each respective dimension table in the data mart. As an example, Figure 5 indicates the ETL process for dim_akun (account dimension).

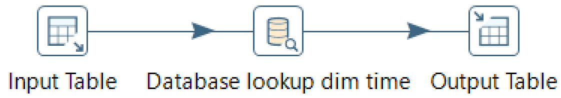

Figure 5. ETL of account dimension

The ETL process of fact_saldo_internal (internal balance fact) can be seen in Figure 6 with four main steps: extracting internal balance data from the operational database, retrieving the foreign key from the account dimension table using lookup; retrieving the foreign key from the department funding source dimension table using lookup; and storing the data in the fact table of internal balance.

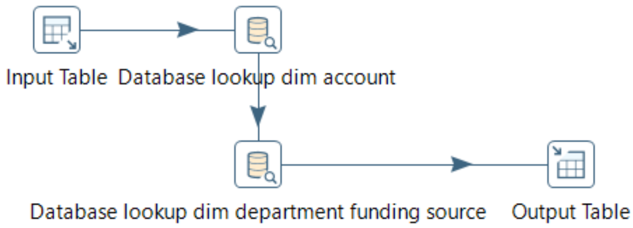

Figure 6. ETL of internal balance fact

The fact_transaksi_internal (internal transaction fact) ETL process included a sequence of transformation steps. After extracting the data, four lookup steps were performed on the time, finance project, account, and department funding source dimension tables to retrieve its foreign keys. A filtering step was added based on the coupon code. The filtering coupon step is used to mark transaction data. As a result of an inadequate data source, some transactions lack a coupon code. This phase is intended to provide both complete and incomplete transaction data with a distinguishing column. In this step, we could If a coupon code is detected, the attribute coupon will have a true value. On the other hand, if no coupon is detected, a false value will be given. Figure 7 shows the complete process.

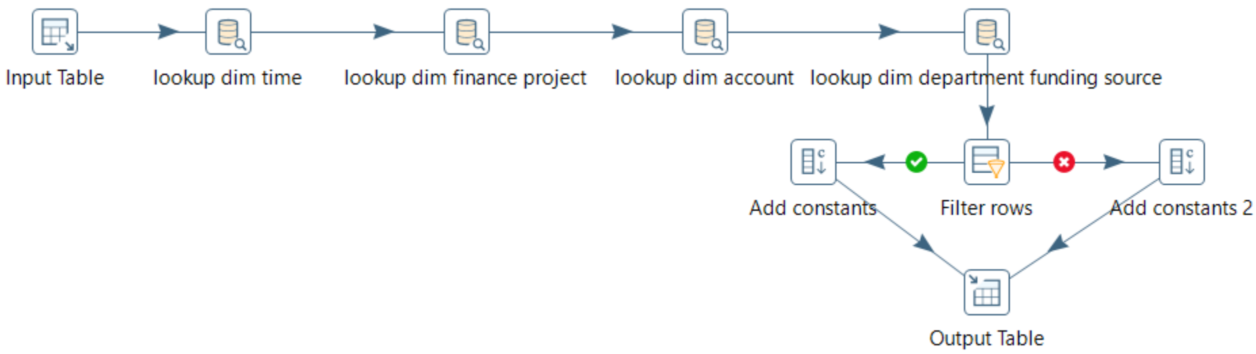

Figure 7. ETL of internal transaction fact

As seen in Figure 8, the fact_produktivitas (productivity fact) ETL operation utilised two data sources, namely transaction and employee position tables. The transaction table as obtained via a query join, and its month and year were extracted from the date column using the calculator filter. The acquired data was then ordered and grouped by its debit and credit total.

Employee position data was collected via a query join, with the month and year derived from the date. Using the select values feature, we deleted columns that were unnecessary for this fact table. We then took the unique data based on the employee ID, month, and year which was then ordered and grouped. During the process of grouping, the number of employee ID is computed, and the aggregation results are input into a new column called jumlah_karyawan (number of employees).

Using stream lookup, jumlah_karyawan is combined with transaction data. Next, lookup to time and department funding source dimension tables were performed to gain its foreign keys.

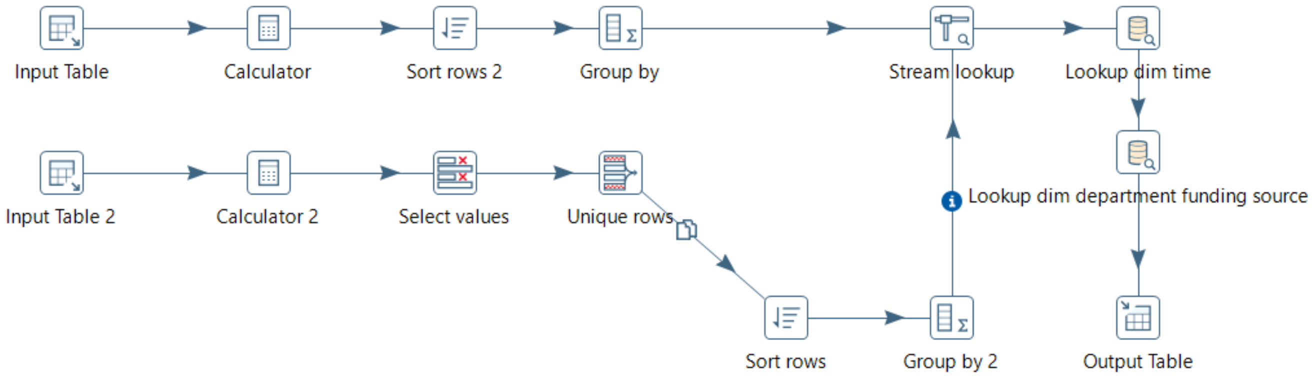

Figure 8. ETL of productivity fact

Figure 9 depicts the ETL process for fact_anggaran_internal (internal budget fact). Initially, the data is extracted using query join. Using the select values feature, the data type for year is converted to string. Next, lookup to time, finance project, and department funding source dimension tables were conducted to obtain its foreign keys.

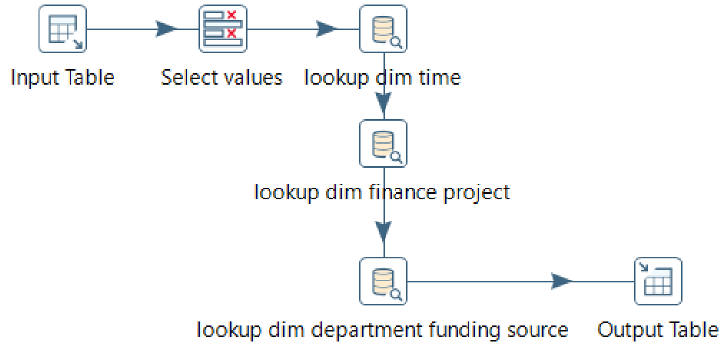

Figure 9. ETL process of internal budget fact

B. *OLAP Implementation*

At this stage, we utilised the Python library Atoti to assist with OLAP analysis by constructing a data cube and a simple dashboard. This step's primary objective is to determine whether the final data mart satisfies the defined analysis requirements. We used Jupyter Notebook and imported the Atoti library. Using the read_sql function, both dimension and fact tables are read. Then, each fact table is assigned its own cube. Every cube consists of level, hierarchy, and measure. Level is used to classify data, which then can be used to construct hierarchical clusters with a parent-child structure. Following the definition of hierarchies, measures are defined.

There are several stages involved in defining measures in internal balance fact. The final balance amount is used to calculate the financial ratios. To filter the final balance, however, the account group must be used. The ending balance of petty cash, currency, and bank accounts comprise the total cash and cash equivalents. The total current asset is calculated by adding the total cash and cash equivalents to the receivables and advances. To calculate investment, net fixed assets, and total noncurrent assets, the ending balances are added. The final balance amount is filtered by account grouping. The total noncurrent asset is derived by adding together investments and net fixed assets.

Current debt comprises members' liabilities and savings, institutional and programme obligations, institution operational obligations, donations and donations received in advance, staff debts, current liabilities, programme fund payables, debts, grants received in advance, deposit funds, and liabilities. Account groups are used to filter all ending balances. After that, the total current liabilities are calculated by adding all the filtered final balances. Noncurrent liabilities are obtained by filtering the ending balance on the noncurrent liabilities group. Total noncurrent debt will be utilised to calculate SATUNAMA's total debt. Total debt consists of both current debt and noncurrent debt, whereas total asset is comprised of both current assets and noncurrent assets. Using the formula for calculating financial ratios, Equation 1 shows that the cash ratio is determined by dividing total cash by total current liabilities. Equation 2 shows that the current ratio is calculated by dividing total current assets by total current liabilities. The ratio of total debt is obtained from total debt divided by total assets and can be seen in

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Equation 3 [26]. The use of the cash ratio formula from Equation 1, current ratio formula from Equation 2, and total debt ratio formula from Equation 3 can be seen in Figure 13.

$$CR = \frac{C}{CL} \qquad (1)$$

Where *CR* = cash ratio, *C* = cash and cash equivalent, *CL* = current liabilities

$$CuR = \frac{CA}{CL} \qquad (2)$$

Where *CuR* = current ratio, *CA* = current assets, *CL* = current liabilities

$$TDR = \frac{TL}{TA} \qquad (3)$$

Where *TDR* = total debt ratio, *TL* = total liabilities or debts, *TA* = total assets

The fact_produktivitas (productivity fact) is used for productivity level analysis. We defined the fact and dimension tables, as well as its measures, for its cube. As shown in Equation 4, productivity is determined by comparing the expenses represented by the total debit to the number of employees. This measure can be viewed from various perspectives according to the required hierarchy. The use of the productivity formula from Equation 4 can be seen in Figure 17.

$$P = \frac{OH}{NoE} \qquad (4)$$

Where *P* = productivity, *OH* = overhead of each department, *NoE* = number of employees from each department

The budget cube is based on the internal budget fact which is related to finance project, time, and department funding source dimensions to analyse budget effectiveness. The budget effectiveness is determined by comparing the actual budget to the total budget, as seen in Equation 5. Multiplying the result of the comparison by 100 yields the percentage of effectiveness [27]. The greater the budget's effectiveness, the more efficiently the budget is utilised by the organisation. Based on the previously established hierarchy, the budget's effectiveness can then be evaluated. The use of the budget effectiveness formula from Equation 5 can be seen in Figure 14.

$$BE = \frac{RB}{TB} \times 100\% \qquad (5)$$

Where *BE* = budget effectiveness, *RB* = realized budget, *TB* = target budget

Next, the cube is defined for internal transaction fact which is used to answer percentage of income, percentage of expenses, comparison of current and noncurrent liabilities expenses, as well as comparison of donor and internal income. Consequently, measures related to these requirements are added, including total expenses, expenses for current and noncurrent liabilities, percentage of expenses for current and noncurrent liabilities, total income, internal and donor income, percentage of income, percentage of expenses, percentage of donor and internal income.

After defining cubes to represent each fact table, the next step was to develop a dashboard. First, a pivot table dashboard for analysing various hierarchical levels was developed. Figure 50 depicts the pivot tables generated by the balance cube, which include financial ratios, total cash, total current assets, total current liabilities, total debt, and total assets. Based on the relations of the balance cube, these six pivot tables can also be viewed from the perspective of source of fund, department, and unit. However, financial ratios are typically viewed in terms of time and use overall data, so the data presented is the total financial ratio for each year.

Rasio Kas

tahun	rasio_kas
Total	2.04
2016	2.01
2017	11.02
2018	1.44
2019	9.52

Sum

Rasio Lancar

tahun	rasio_lancar
Total	2.87
2016	2.04
2017	13.01
2018	1.68
2019	16.47

Sum

Rasio Total Hutang

tahun	rasio_hutang
Total	.16
2016	.14
2017	.04
2018	.21
2019	.02

Figure 50. Pivot Tables of Financial Ratios

Figure 61 shows one example of the pivot table used for department productivity. The tables for income, expenses, income from internal funds, income from donor funds, expenses for current liabilities, and expenses for non-current liabilities are taken from the transaction cube. Data related to productivity is from the productivity cube. Each measure can be analysed to its lowest granularity from time (year, semester, quarter, month) and funding source (source of fund, department, unit) dimensions.

Produktivitas

nama_sumber_dana	nama_departemen	tahun	Produktivitas
BKUK			23,569,623.96
	Pembangunan Berkelan...		23,569,623.96
		2016	116,221,800.83
		2017	1,392,582.58
		2018	538,663.56
		2019	11,738.28
		2020	137,413,631.00

Figure 61. Pivot Tables for Use of Funds

Figure 72 illustrates the budget effectivity pivot table. Users can view measures such as total budget, budget realisation, as well as the percentage of effective use of the budget. These measures can also be regarded from the perspectives of time, funding source, and finance programme.

Efisiensi RAB

tahun	nama_sumber_dana	nama_keuangan_program	total_anggaran.SUM	realisasi_anggara...	Efektivitas Angga...
Total			985,982,997.46	474,396,569.00	48.11
2020			985,982,997.46	474,396,569.00	48.11
	RPKJ		985,982,997.46	474,396,569.00	48.11
		Rumah Pembelajaran Kesehatan Jiwa (RPKJ)	985,982,997.46	474,396,569.00	48.11

Figure 72. Pivot Table for Realisation of Budget Estimate Plan

The second form of dashboard displays the analysed data graphically. Figure 83 displays a dashboard of financial ratios, including the cash ratio, current ratio, and debt ratio in the form of bar graphs. Red color indicates user must be alert and pay attention to the ratio. Blue color depicts the ratio value being in a neutral condition where users could try to increase the ratio. Green color indicates user that their financial ratio is in very good conditions and the user should maintain their condition. Total cash, total current liabilities, total current assets, total assets and total debt are also added in the bar graphs for added information. Additionally, users can filter the data based on year to compare multiple years.

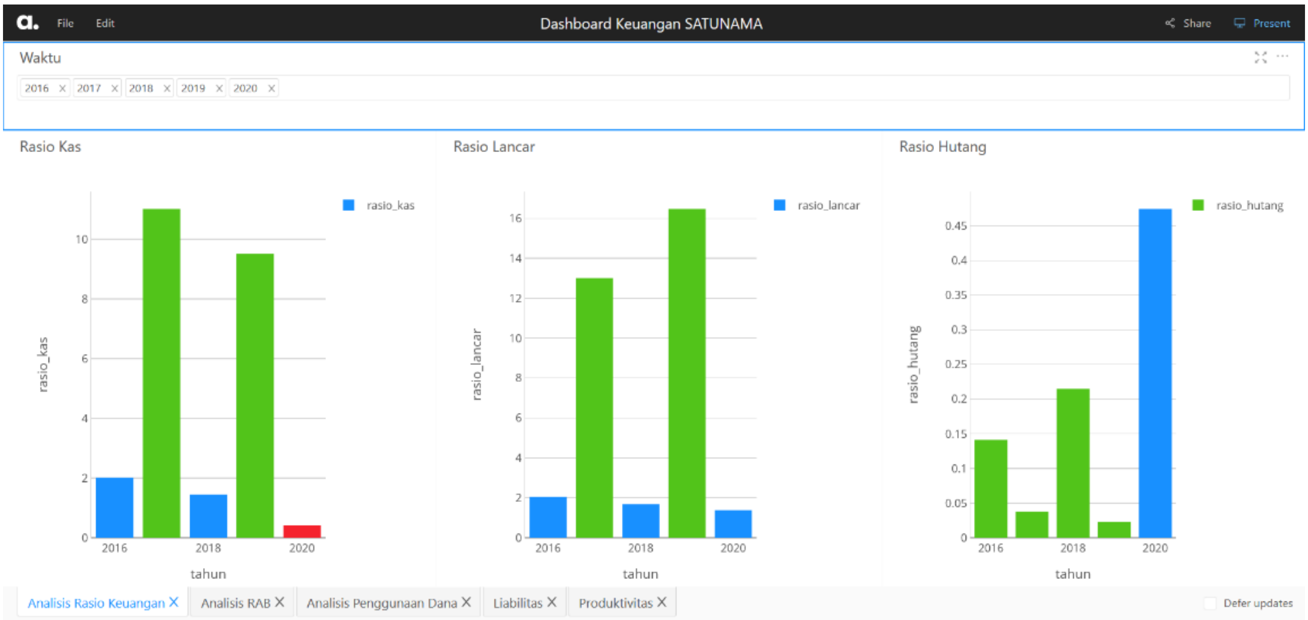

Figure 83. Financial Ratios Dashboard

Figure 94 presents a dashboard for analysing Budget Estimate Plan data. Users can observe the budget and its implementation based on the name of the finance project. In addition, users can view the effectiveness of the organization's use of funds, allowing for better and more targeted future budget planning. All visualisations have the option of being filtered by time, department, programme name, and project name.

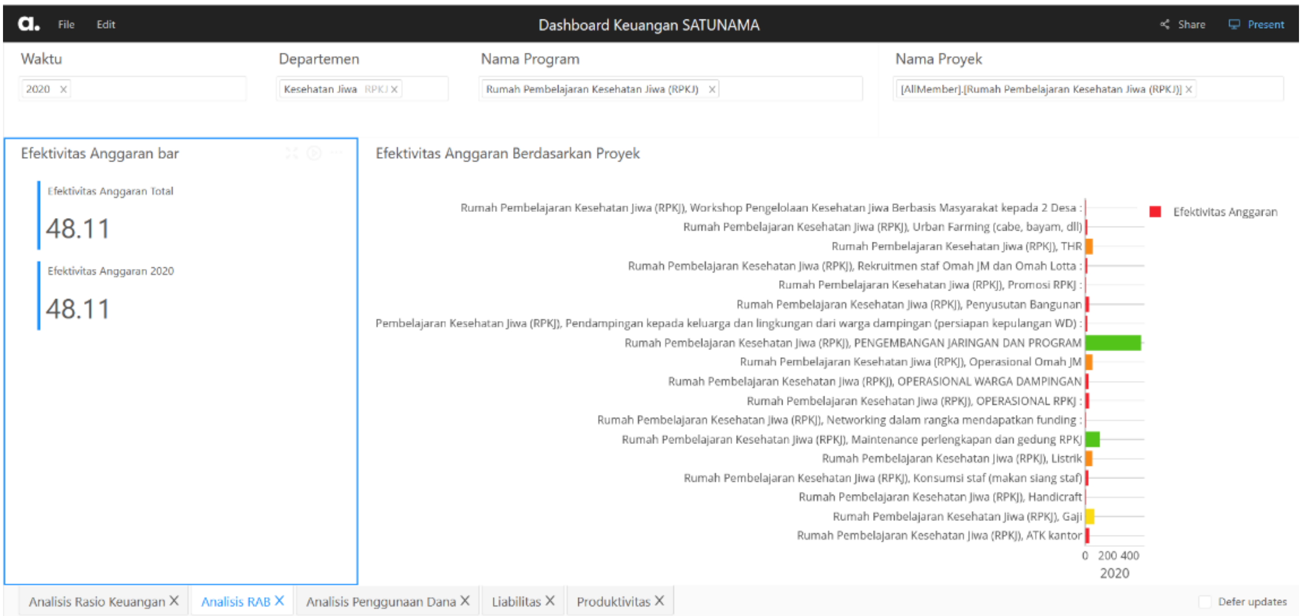

Figure 94. Budget Estimate Plan Realisation Dashboard

Figure 5 depicts a visual analysis of the spending of funds. This dashboard allows users to view the percentage of income and expenses, as well as the percentage of funds received from both internal and external donors. The ability to manage finances can be seen from the balance between expenses and income. SATUNAMA's internal income is expected to be able to compete with income from external donors. When there is a large difference between income from donors and internal income, SATUNAMA must prepare a strategy to increase its internal income. We applied bar graphs to assist users in comparing percentages [28]. Time can also be used to filter the data.

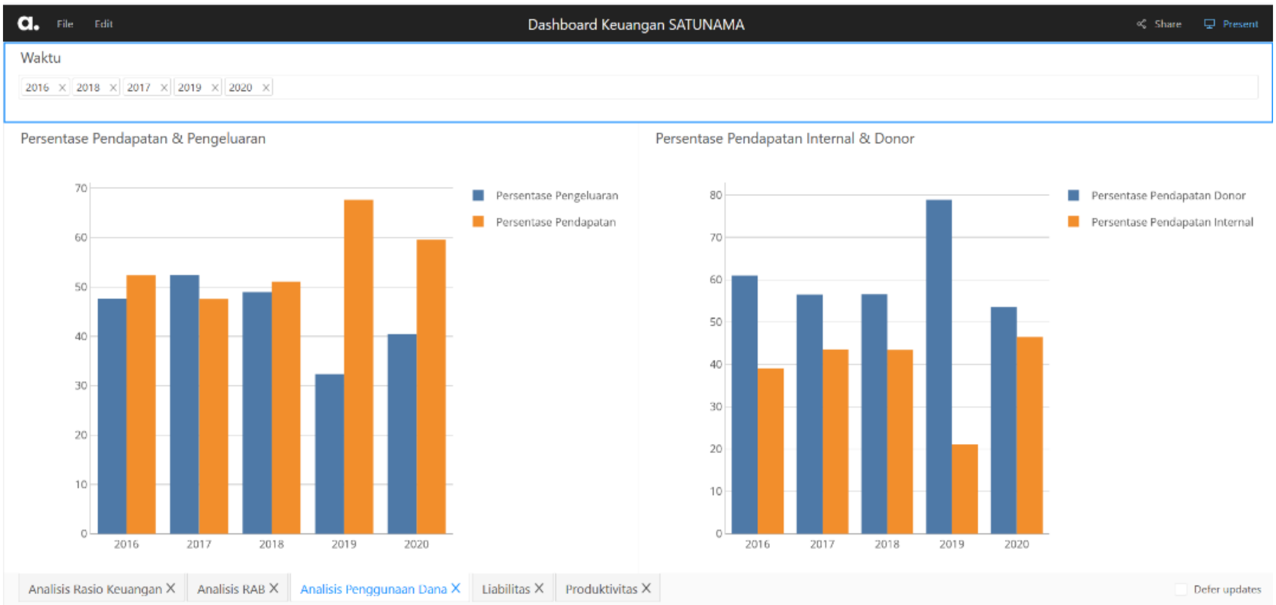

Figure 15. Use of Funds Dashboard

Figure 106 shows the dashboard for liability data. Users are able to view the proportion of expenses used to finance current and noncurrent liabilities. The information can then be filtered by time and funding source. Users can use this data to control expenses related to liabilities on future targets.

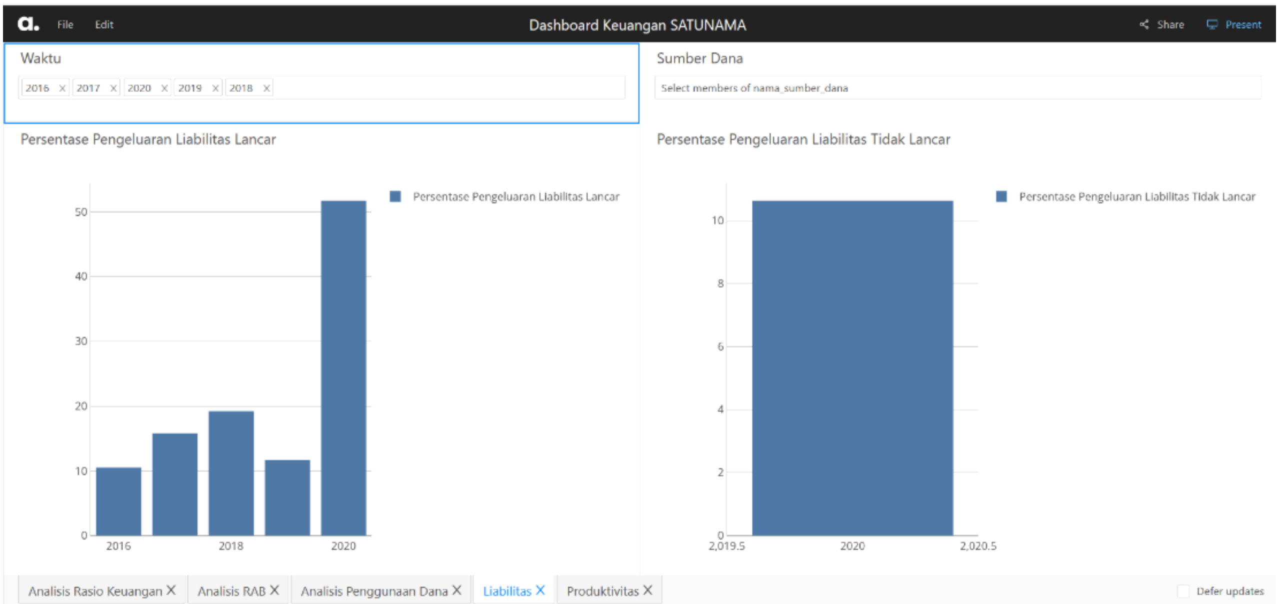

Figure 106. Liability Dashboard

Figure 7 shows the productivity dashboard that can be utilised to analyse productivity level, employee count, and overhead costs. A filter is also available based on time and department. Users can see which departments are the most productive at certain time periods. Based on available data, SATUNAMA can set future departmental budgets according to historical productivity data.

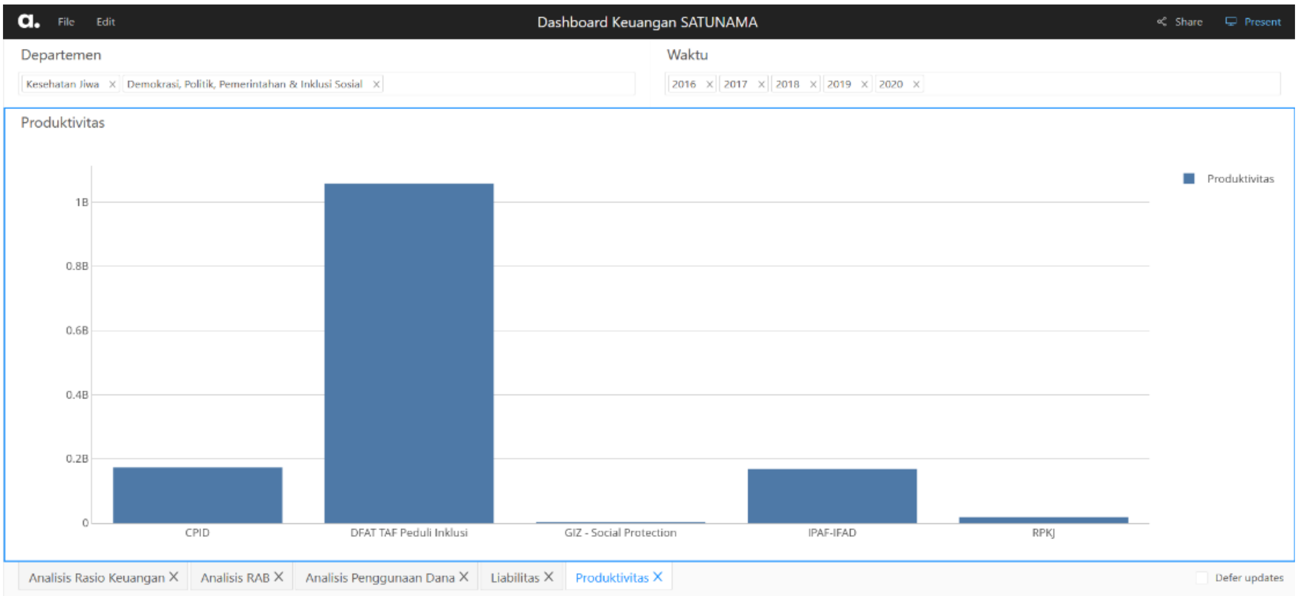

Figure 17. Productivity Dashboard

C. Evaluation

First, we evaluated the data mart to the analysis criteria established at the beginning of the study. Additionally, we also assessed our financial data mart using the approach proposed by ESheta and Eldeen [24], which consider the evaluation of data characteristics and operational data perspectives.

1) Data Mart Evaluation with Analysis Criteria: This financial data mart is intended to support the financial analysis of SATUNAMA. The analysis criteria defined at the outset of this study served as the foundation for the development of our data mart. Due to the limited data available, we discovered that certain analysis criteria could not be viewed with the smallest granularity. For instance, the analysis criteria associated with the balance and budget cubes can only be viewed annually. This is because both cubes utilised the time dimension in the account dimension. In the meantime, data in the productivity cube can be examined down to the month level and data in the transaction cube can be viewed on a daily level.

All analysis criteria and measures can be viewed from the funding source, department, and unit perspectives. However, only analysis criteria associated with the transaction and balance cubes can be viewed from the account group and account code perspectives, while analysis criteria associated with the budget and productivity cubes can be viewed from the finance programme and finance project perspectives.

2) Data Characteristics Evaluation: In terms of data characteristics, there are four aspects of evaluation: data reliability, integration, capability, and management. Regarding data reliability, this financial data mart obtains its data from the operational database of SATUNAMA. During the process of importing raw data into the operational database, several considerations must be made. First, it is necessary to standardise the structure and format of the data. The entered information should also be consistent with financial performance. All required financial data for criteria-based analysis is loaded into the operational database, which will subsequently serve as the data source for the financial data mart.

Due to the large amount of Excel-formatted raw data, we were unable to integrate all financial data into the operational database. We used available financial data from 2016 to 2020. Consequently, it should be noted that the OLAP dashboard visualisation depicts only a subset of the available financial data at SATUNAMA.

Based on data integration, this financial data mart is sourced from the financial operational database which is integrated using PDI. Multiple dimension tables are utilised concurrently by the fact tables. Even though there are different needs for analysis, dimension table data is stored in a single data mart. Adjustments are made to the column requirements of the dimension table when the table is read using Atoti. The constructed OLAP is directly integrated with the financial data mart, allowing any additional data in the data mart to be read directly into OLAP. Additionally, each table's primary key is generated automatically to reduce human error.

In terms of data capability, data mart should have the capacity to store historical financial data. The data mart contains a time column for financial data so that data can be analysed from various timeframes. We recommend SATUNAMA to provide additional data in the operational database to supplement the existing data for a more comprehensive financial analysis. During the development of this financial data mart, we discovered that only the transaction data for 2020 is related to the budget data. It is unfortunate that the data from earlier years could not be located, as both are essential for evaluating the financial performance of NPO.

Due to the fact that the current data only includes the number of incoming and outgoing funds during a specified time period, the amount of information that can be utilised to make decisions is limited. We suggest SATUNAMA to establish precise financial objectives accompanied by quantifiable metrics for evaluation. To illustrate, SATUNAMA has yet to establish precise objectives pertaining to the allocation of its financial resources, which has resulted in an absence of data suitable for more comprehensive analysis.

In the case of data management, data is only inserted into the data mart and is never updated or deleted. After annual financial auditing, data is inserted into the data mart. Each table's primary key is generated automatically using the auto-increment function. It should also be noted that since SATUNAMA uses SANGO for its daily transactions, future data must be restructured in accordance with the operational database's structure to facilitate the ETL process.

3) Operational Perspectives Evaluation: To evaluate in terms of operational perspectives, we used PDI which makes the ETL process quicker and easier. Apart from that, the data source is centered from the operational database, and we utilised the query join feature in PDI to obtain the relevant data. During ETL, PDI is used for the data cleansing procedure. The process consists primarily of reorganising the data according to the data mart schema. Due to time constraints, not all data were entered into the data mart for analysis. In terms of data loading performance, we ensured that the extracted and cleaned data were loaded into the financial data mart according to the predefined schema.

To assess query performance, queries for budget effectiveness, expenditures for non-current liabilities, expenditures for current liabilities, internal funds, donor funds, department productivity, spending percentage, expenditure percentage, total debt ratio, current ratio, and cash were run five times each in the operational database and data mart. There are 12 tables in the operational database which are processed into 4 fact tables and 4 dimension tables. The fact table consists of an internal transaction fact table (21133 rows), internal balance fact table (12896 rows), productivity fact table (480 rows), and internal budget fact table (18 rows). Specifically, the internal budget table only uses data from the year 2020 while the rest uses data from the year 2016-2020. As shown in Table 4, the average of the results for each query in each database was then calculated and compiled for comparison. The result demonstrates that the data mart has a query duration approximately one second quicker than the operational. This indicates that the financial data repository performs better than the operational database. This is the result of the data mart's starflake schema, which incorporates normalised and denormalized tables. The operational database, on the other hand, uses a more normalised schema. The process of database normalisation leads to an increase in the number of tables, which in turn affects the execution time of queries by requiring more joins.

TABLE 4
QUERY TIME COMPARISON

Analysis Criteria	Query Time Database Operational (second)	Query Time Data Mart (second)
Budget effectiveness	0,4658	0,0838
Expenditures for non-current liabilities	0,4166	0,0734
Expenditures for current liabilities	0,1938	0,0626
Internal funds	0,2004	0,0828
Donor funds	0,1932	0,0616
Department productivity	0,3706	0,0704
Spending percentage	0,2024	0,0882
Expenditure percentage	0,1776	0,0746
Total debt ratio	0,403	0,0794
Current ratio	0,397	0,0736
Cash ratio	0,3756	0,0712
Total	0,3087	0,0747

IV. CONCLUSION

This study demonstrates that the financial data mart developed can fulfill the necessary analysis needed for the Finance Department of SATUNAMA. We managed to extract, clean, and load data from the operational database into a data mart. Furthermore, we also used dashboards containing pivot tables and graphs to project the queries into visualisations. Some limitations include the lack of detailed data which impacted the granularity of the analysis. Analysis for cash ratio, current ratio, total debt ratio, and budget effectiveness cannot be expanded to smaller granularity because the data source is in the form of aggregation. The four-step Kimball method is suited for the case of non-profit organisation. Each process in this method is clearly defined, which facilitates the development of the data mart. This research has produced a financial data warehouse with a starflake schema. Moreover, our evaluation demonstrates that this data mart outperforms the operational database.

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