DESIGN OF DATA WAREHOUSE ARCHITECTURE FOR TRACER STUDY DATA MANAGEMENT BASED ON OLAP

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Abstract

The university conducts a tracer study to obtain information about job search and the work situation of alumni after graduating from university. So the university will collect tracer study data from year to year. Therefore, the data integration is carried out so that the use of tracer study alumni data as material for analysis becomes more effective. By using the concept of a data warehouse, it will simplify the process of integrating tracer study data. With the implementation of OLAP technology can generate data analysis reports as a basis for decision-making. The data in data warehouse tracer study will be input data in the OLAP (online analytical processing) application. This study designs a multidimensional schema model with a snowflake schema for a data warehouse tracer study. By determining a sample attribute based on predetermined criteria, it can be a measure for making dimensions. Based on the results of the analysis obtained one fact table and nine dimension tables.

Keywords: Data Warehouse, Multidimensional, OLAP, Snowflake, Tracer Study

Introduction

The quality of human resources produced by a university affects the university's accreditation. One of the factors that influence accreditation is the quality of alumni from the university. The sooner alumni get jobs, the better the quality of alumni will be. Therefore, the university conducts a tracer study to obtain information related to job search, and the work situation of alumni after graduating from university. From year to year the alumni data at Widyatama University is increasing. So it requires a proper data collection and processing process. However, the data has not been processed properly because the data processing is still manual so that the resulting data is not optimal for the decision-making process by the Career Center as an institution that manages alumni data at Widyatama University. The concept of a data warehouse is a solution to overcome these problems. Therefore, in this study, we want to design a data warehouse tracer study at Widyatama University in order to facilitate decision making by the career center section[1-3].

There are three types of data warehouse modeling, namely star schema, snowflake schema, and galaxy schema. The star schema consists of a fact table as a central table which generally contains non-redundant data and a dimension table for each dimension. Star schema modeling allows for easy modification or continuous development of the data warehouse. However, it can cause data integrity problems because the data in the star schema can appear over and over again. The data in the snowflake schema will be normalized, this causes the storage in the snowflake to be smaller than the star schema. However, the query process becomes slower because of combining data to produce output. While modeling using a galaxy schema can accurately model several fact tables, modeling becomes difficult to design and manage due to the presence of multiple fact tables. This study uses snowflake schema modeling because there are several dimension tables in the tracer study data that must be normalized. It is intended that there is no redundant data so as to facilitate the withdrawal of the data warehouse[4, 5].

With OLAP, database queries can be performed quickly, easily and efficiently. Implementation of OLAP technology can generate data analysis reports as a basis for decision making. OLAP manipulates data efficiently from multiple perspectives or views. This makes it easier to analyze by looking at the data from various perspectives. The data in the data warehouse tracer study will be used as input data for the OLAP (online analytical processing) application.

Of the several schemes and techniques that can be used in designing a data warehouse, this study only made a schema for modeling, using OLAP for analysis and also making a scheme data measurement from the data warehouse. The scheme used in this study is a snowflake scheme because the data from this follow-up study requires normalization. The data in this study requires multidimensional analysis, so the use of OLAP is necessary because the use of OLTP alone cannot support this performance.

Literature Review

Tracer Study

Tracer study is a survey carried out by universities, as a form of supervision in terms of job search, work situations and utilization of competency acquisition that has been produced by universities[1, 2, 6, 7].The definition of tracer study according to [8] is a study that aims to obtain information about graduates who are already working and not working. In addition, the tracer study also aims to determine the results of training in the form of mastery and acquisition of the skills of graduates that are implemented in the world of work and the transition from the world of higher education to the world of business and industry. Benefits to be gained from implementing the follow-up study include:

1. Could identify stakeholder satisfaction from the results of each student's learning experience process, which will then be used as a benchmark to assess college performance
2. Could establish relationships between students and students
3. Could find out the distribution of college alumni graduates

Database

A database is a collection of information stored in a computer system it can be checked using a computer program to obtain information from the database. The database is a representation of a collection of interconnected facts stored together in such a way and without unnecessary repetition, to meet various needs. The database is a collection of interrelated information on a particular subject for a specific purpose. [9-11].

The basic concept of a database is a collection of records or chunks of knowledge. A database has a structured description of the types of facts stored in it, these descriptions are called schemas. A schema describes the objects that a database represents and the relationships between those objects. The model that is commonly used today is the relational model, which according to Layman's terms represents all information in the form of interconnected tables where each table consists of rows and columns.

Data Warehouse

According to [12] Data Warehouse is a summary of a collection of logical data based on an operational database. The data warehouse concept is a combination of technologies that make it easier for organizations to manage and maintain historical data obtained from an operating system or applications. It is also believed that a data warehouse [13-15] consists of data made up of subjects intended to support the decision support function. The function of creating a data warehouse as a data storage medium to support system decision making is necessary for top management with the help of data visualization in the form of a dashboard containing a flexible report. Data warehouses can also facilitate the work of business intelligence analysis and reporting. There is a data repository in the data warehouse, where data from operational databases and other sources can be integrated, cleaned and archived to support decision making. [6].

Data Model

The creation of a data warehouse is based on a multidimensional data model. This model displays the data in the form of a cube. The multidimensional data model consists of dimensions and facts[16, 17]. A database schema contains a collection of entities and entity relationships. A data warehouse requires concise, subject-oriented schemes that can be used in online data analysis. The schema types of multidimensional data models are [4, 15, 18].

Star Scheme

The star scheme is the simplest data warehouse schema. This schema is called a star schema because the relationship between dimension tables and fact tables resembles a star, where one fact table is linked to multiple dimension tables. The center point of the star scheme is a large fact table, and the corners are the dimension tables. Advantages of using a star scheme:

a. Data response is faster than operational database design.
b. Facilitate the continuous modification or development of the data warehouse.
c. End-users can customize the way they think and use the data.
d. Simplify understanding and search metadata for users and developers.

1. Snowflake Scheme

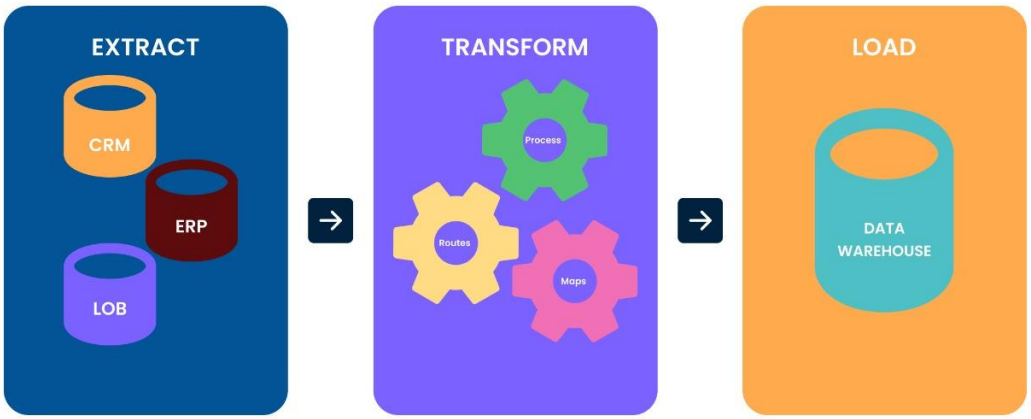
The snowflake schema is a variation of the star schema in which some dimension tables are normalized. This results in several additional tables. The advantage of using this scheme is that it saves memory, but it increases the time required for query processing.

2. Galaxy Scheme

In the galaxy schema, multiple fact tables share a dimension table. The advantage of using this scheme is to saves memory and reduces errors that may occur[19].

ETL

According to [10], the ETL process, which consists of three processes, namely extraction, transformation and loading, is the process of acquiring data from the data source and transferring it to the data warehouse. In this process, a data cleansing process will be carried out in order to obtain quality data. Extract, transform, load (ETL) is a very important process in a data warehouse, and you can enter this ETL data from



the operating system into the data warehouse. The purpose of ETL is to collect, filter, process, and combine data from various sources and store it in a data warehouse.

There are two tables in ETL, namely the fact table and the dimension table. The fact table is a table representing the topic to be analyzed where the data in the table is directly related to business processes. Whereas the dimension table is a table representing the analysis axis which is used to limit the query scope and the data contained in the dimension table which rarely changes

Most of the data in the source system is so complex that it is very difficult to identify the relevant data. The task of designing and carrying out the extraction process takes a long time. Raw data from the source system can usually be stored directly in the staging area with minimal reconstruction to maintain data reliability. There are three common extraction methods that is extract, transform and load.

OLAP

OLAP (online analytical processing) is a form of business thinking that encapsulates the relationship between reporting and data mining. OLAP can be used specifically to process business reports related to sales, marketing, budgets, and forecasts. With the help of OLAP, database queries can be done quickly, easily and efficiently. The implementation of OLAP technology can produce sales data analysis reports as the basis for decision making and determining company strategy. In addition, through the implementation of data warehouses and reports of the OLAP process, as well as with the support of a dashboard application, reports and sales status can be more easily presented to make it easier for users to read reports. for decision making.

OLAP is a set of rules that provides a dimensional framework to support decision making. OLAP is also an approach to rapidly providing answers to multi-dimensional analytical queries. OLAP is part of the more comprehensive category of business

thinking, which also encapsulates the relationship between reporting and data mining. At the core of the distribution of the OLAP system is the concept of an OLAP cube (also known as a multi-dimensional cube or hypercube) which consists of numeric facts called sizes and classified as dimensions[20, 21].

OLTP

OLTP is a database that processes data or accesses data in real-time and supports transaction processing. Usually used for critical applications. According to Rainer and Turban: OLTP (Online Transaction Processing) is the management of transaction data online directly after the transaction occurs. According to Connolly and Begg: OLTP is a system designed to manage high-level transaction data processing with data that makes little impact on the organization's day-to-day operational data [22].

OLTP is an operating system that supports transaction-oriented applications in a 3-tier architecture. Manage the day-to-day transactions of an organization. OLTP essentially focuses on query processing, maintaining data integrity in multiple access environments, and efficiency, measured in terms of the total number of transactions

per second. The full form of OLTP is online transaction processing.

Research Methods

Data Collection Methods

This research was conducted by adding data as a consideration, to get an idea of a problem. The method of data collection is done through literature studies in the form of journals, books, and written works about data warehouses as a source of data collection. In addition, the interview and observation process directly to the career center widyatama as a career management center that supports tracer study for alumni at widyatama university.

1. The observation method is carried out to the career center of widyatama university to observe what is needed for the design of tracer study data
2. The interview method is conducted to the career center of widyatama university to obtain primary data, later the data will be used in designing data warehouse tracer study of widyatama university

Research Prosedure

This research was conducted by following the research methodology of Ranjit Kumar. This methodology can provide an overview related to the research journey carried out, to produce good and structured research. This research method consists of 8 steps:

Step 1 : Formulating a Research Problem

This step is very important because it sees the problems that occur in the research process that will be quickly resolved. The research process has a problem, namely the tracer study which previously did not have systematic data processing and was still manual through excel documents for data processing and storage. Therefore, this research was conducted to overcome these problems and provide benefits to the university in managing data and when conducting tracer study alumni research to be used as decision making by stakeholders[23].

Step 2 : Conceptualizing a Research Design

In this step, research is conducted using existing data and the data collection is carried out using quantitative methods and with statistical dataset techniques, this is done by observation and also interviews with the university. And then do the schema design in making the data warehouse, the schema used is the snowflake schema. The research was conducted using the size analysis stage and saw what aspects of the dimensions were used. Measure analysis can measure the level of analysis of a data warehouse and view from various aspects.

Step 3 : Constructing an instrument for Data Collection

This study uses primary data obtained from the career center of Widyatama University with observation and interview methods.

Step 4 : Selecting a Sample

The sample data obtained from the career center is alumni data for the past 5 years. In this study, the tracer study alumni data obtained were divided into 3 data formats :

1. Excel (xlsx) obtained from the results of the tracer study questionnaire
2. Word (docx) which contains a report document of the results of the tracer study
3. Excel (csv) which is exported from the career center website

Step 5 : Writing a Research Proposal

1. The purpose of this study is to facilitate decision making by the career center section in providing and presenting alumni data quickly, interactively, and attractively
2. This design concept is made by making schemas and data flow charts to determine the size of the data to be used.
3. This study only discusses the design of a data warehouse using a snowflake scheme with a data flow chart.
4. The data used in this design is data created by researchers with several attributes that match the problem
5. The research report that will be submitted consists of several chapters, introduction, literature review, research methods, results and discussion, conclusions, suggestions, and references.
6. The limitations of this study are only discussing schema design and making data flow charts, and the data used is the design data.

Step 6 : Collecting Data

In collecting the data obtained in the form of datasets. The data consists of 10 attributes. These attributes can be used as sizes and dimensions. The following 10 attributes are :

Table 1

Attributes Fact Tracer Study

No	Attribute Name	Description
1.	id_tracer	Alumni tracking code
2.	id_alumni	Code of alumni name
3.	id_fakulty	Faculty code taken by alumni
4.	id_time	Time code in work entry
5.	id_job	Code from the jobdesk occupied by alumni
6.	id_company	Company occupied by alumni code
7.	id_salary	Salary received by alumni code
8.	id_location	Job location code
9.	id_suitability	The suitability between the education studied and the work code
10.	id_problem	Code alumni problems in finding work

Step 7: Processing and Display

In this study, for the case study, the tracer study was carried out using the application of data processing, namely Kettle Pentaho. Later in the application, a process called the ETL process or Extract, Transform, Load is carried out. Furthermore, the OLAP application will be built by forming a data cube structure in the OLAP Server.

Figure 2. Data Warehouse Architecture

Step 8 : Writing a Research Report

In the last step, a research report will be made which consists of 5 chapters, introduction, literature review, methodology, results and discussion, conclusions, and references.

Result and Discussion

The design of the data warehouse begins with determining the process of the operational section as the subject of the business process to be built. In this study, the object that will be used is the tracer study section contained in the career center at Widyatama University. By using tracer study alumni data that has been obtained, the data analysis process can be carried out by determining the right attributes for data warehouse design. The attributes to be used can be determined based on the following criteria:

1. Attributes are selected according to the needs of the data to be displayed

2. Attributes that can be related to attributes in other tables
3. Data is not null or less than 10%

The next step is to determine the attributes that will be used in the design of the data warehouse to be used as measurements and dimension adjustments. From the results of data analysis, there is 1 fact table and 9 dimension tables. The fact table that has been determined is tracer study facts, while the dimension table formed consists of alumni dimensions, job dimensions, company dimensions, salary dimensions, location dimensions, faculty dimensions, time dimensions, suitability dimensions, and problem dimensions. Based on the table that has been determined, a multidimensional schema model can be designed using the snowflake schema which can be seen in figure 4

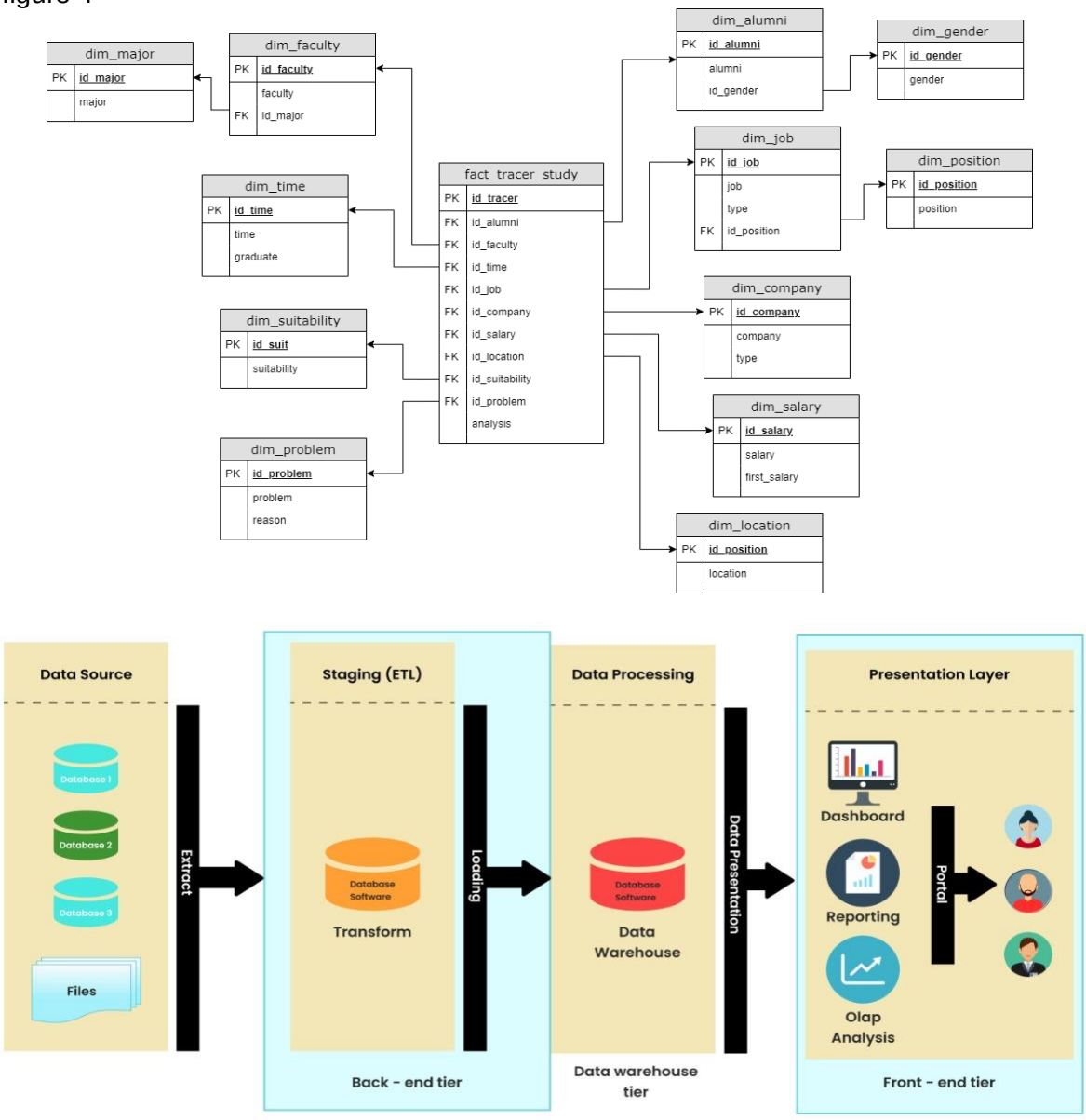


Figure 3. Snowflake Scheme Tracer Study

Based on the snowflake schema that has been built, a complete explanation of the data structure of the fact table can be seen in table 2. The fact table consists of a set of attributes containing the names of facts (size) and keys from the dimension tables that are related to the fact table.

Table 2

Data Structure Fact Tracer Study

No	Attributes Name	Type	Size	Properties	Description
1.	id_tracer	Int	10	Primary Key (Auto Increment)	Alumni tracking code
2.	id_alumni	Int	10	Foreign Key	Code of alumni name
3.	id_faculty	Int	10	Foreign Key	Faculty taken by alumni Code
4.	id_time	Int	10	Foreign Key	Time in work entry code
5.	id_job	Int	10	Foreign Key	Code from the jobdesk occupied by alumni
6.	id_company	Int	10	Foreign Key	Company occupied by alumni code
7.	id_salary	Int	10	Foreign Key	Salary received by alumni code
8.	id_location	Int	10	Foreign Key	Job location code
9.	id_suitability	Int	10	Foreign Key	The suitability between the education studied and the work code
10.	id_problem	Int	10	Foreign Key	Code alumni problems in finding work

The alumni dimension table is used to accommodate the total alumni who have graduated from the university and can be distinguished by gender. The alumni dimension consists of 3 attributes including id_alumni, alumni, and id_gender. An explanation of the alumni dimension data structure can be seen in table 3.

Table 3

Data Structure Alumni Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_alumni	Int	10	Primary Key (Auto Increment)	Alumni name code
2.	alumni	varchar	50		Alumni name
3.	id_jenis_kelamin	Int	10	Foreign Key	Alumni gender code

The job dimension table can be used to store job data, job fields, and job positions obtained by alumni. The job dimension consists of 4 attributes including id_job, job, type, and id_position. An explanation of the job dimension data structure can be seen in table 4.

Table 4

Data Structure Job Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_job	Int	10	Primary Key (Auto Increment)	Job code
2.	job	varchar	30		Job name
3.	type	varchar	30		Field of work
4.	id_position	Int	10	Foreign Key	Type position of alumni in work code

The company dimension table is a place to store company name data and business fields for alumni who have got a job. The company dimension consists of 3 attributes including id_company, company, and type. An explanation of the company dimension data structure can be seen in table 5

Table 5

Data Structure Company Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_company	Int	10	Primary Key (Auto Increment)	Company code
2.	company	varchar	50		Company name
3.	type	Int	10		Field of work place of business

The salary dimension table is used to store data on the first salary obtained by alumni and the salary received by current alumni. The salary dimension consists of 3 attributes including id_salary, salary, first _salary. An explanation of the salary dimension data structure can be seen in table 6.

Table 6

Data Structure Salary Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_salary	Int	10	Primary Key (Auto Increment)	Salary received code
2.	salary	varchar	30		The size of the salary received by alumni
3.	first_salary	varchar	30		The amount of the first salary received by alumni

The location dimension table is used to store company workplace location data. The location dimension consists of 2 attributes, namely id_location and location. An explanation of the location dimension data structure can be seen in table 7.

Table 7

Data Structure Location Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_location	Int	10	Primary Key (Auto Increment)	Job location code
2.	location	varchar	255		Job location name

The faculty dimension table is the faculty data taken by alumni. This data includes the names of faculties and study programs taken by alumni. The faculty dimension consists of 3 attributes including id_faculty, faculty, and id_major. An explanation of the faculty dimension data structure can be seen in table 8.

Table 8

Data Structure Faculty Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_faculty	Int	10	Primary Key (Auto Increment)	Faculty taken by alumni code
2.	faculty	varchar	50		Faculty name
3.	id_major	int	10	Foreign Key	Study program taken by alumni code

The time dimension table is a place to store alumni time data to get a job and also alumni graduation time. The time dimension consists of 3 attributes including id_time, time, and graduate. An explanation of the time dimension data structure can be seen in table 9

Table 9

Data Structure Time Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_time	Int	10	Primary Key (Auto Increment)	How long does it take for alumni to find work code
2.	time	date			Time to get a job
3.	graduate	date			Time of alumni graduate from university

The suitability dimension table is used to store suitability data between the education taken by alumni and their field of work. The suitability dimension consists of 2 attributes including id_suitability and suitability. An explanation of the suitability dimension data structure can be seen in table 10

Table 10

Data Structure Suitability Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_suitability	Int	10	Primary Key (Auto Increment)	The suitability between the education studied and the work code
2.	suitability	varchar	255		Suitability of education with the field of work

The problem dimension table is used to store data on the problems faced by alumni in finding work, and also the reasons for alumni not getting a job. The problem dimension consists of 3 attributes including id_problem, problem, and reason. An explanation of the dimensions of the problem can be seen in table 11

Table 11

Data Structure Problem Dimension

No	Attributes Name	Type	Size	Properties	Description
1.	id_problem	Int	10	Primary Key (Auto Increment)	Code alumni problems in finding work
2.	problem	varchar	255		Company name
3.	reason	varchar	255		The reason alumni haven't got a job

After designing a multidimensional snowflake model schema, then proceed with designing a data measurement scheme or commonly called a data flow chart for the needs of the data analysis process in the design of a data warehouse tracer study.

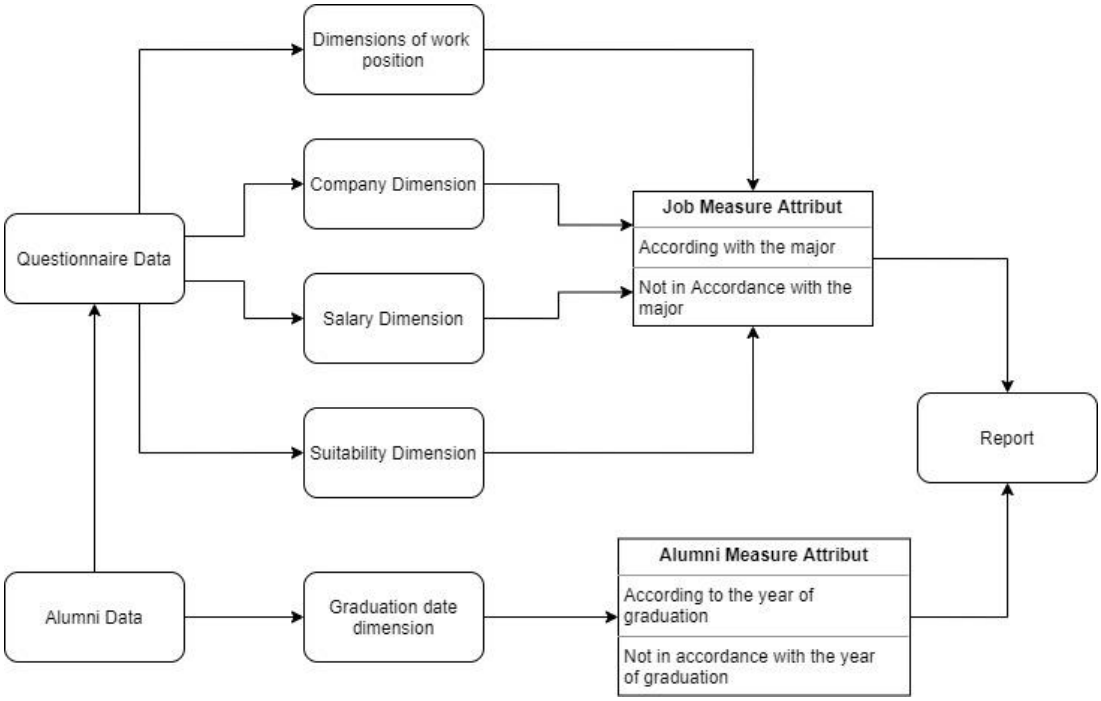


Figure 4. Schema Data Measurement

In the schema data measurement in the figure above, it can be seen that the main data focus in the design of this data warehouse is alumni data from the questionnaire results. And there are several dimensions that exist at this stage of the flow chart including the dimensions of work position, company dimensions, salary dimensions, conformity dimensions, and graduation date dimensions. Finally, in the flow chart, the attributes for measurement in the design of this data warehouse are job attributes where the conditions to be used are appropriate or not appropriate to the work with majors and alumni attributes using conditions that match or do not match the accuracy of the year of graduation.

Conclusion

Based on analysis of the design of the data warehouse tracer study it could be concluded that the use of advanced search descriptors and processes referred to by Ranjit Kumar could help make data warehouse design simpler and more efficient. Starting from formulating research, conceptualizing research design, constructing an instrument for data collection, collecting samples, processing data, processing, and display, and finally the creation of the report of Research. The study was derived from a multidimensional schematic drawing using a snowflake schema for the data warehouse tracer study. When selecting a sample attribute based on established criteria, it can be a dimension to create a dimension. According to the analysis, there are 1 fact table are named fact_tracer_study and 9 dimension tables, while the dimensions formed consist of alumni dimensions, job dimensions, company dimensions, salary dimensions, location dimensions, faculty dimensions, time dimensions, suitability dimensions, and problem dimensions. Following a multidimensional design model of snowflake's scheme, a data measurement scheme continued as a data tracking chart that could be used for the analysis of the warehouse's data study tracer.

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