

Three Tier-Level Architecture Data Warehouse Design of Civil Servant Data in Minahasa Regency

I R H T Tangkawarow*, J P A Runtuwene, F I Sangkop and L V F Ngantung

Universitas Negeri Manado, Tondano 95618, North Sulawesi, Indonesia

*irene.tangkawarow@unima.ac.id

Abstract. Minahasa Regency is one of the regencies in North Sulawesi Province. In running the government in Minahasa Regency, a Regent is assisted by more than 6000 people Civil Servants (PNS) scattered in 60 SKPD. *Badan Kepegawaian Diklat Daerah* (BKDD) of Minahasa Regency is SKPD that performs data processing of all civil servants and is responsible for arranging and formatting civil servants. In the process of arranging and determining the formation of civil servants, many obstacles faced by BKDD. One of the obstacles is the unavailability of accurate data about the amount of educational background of civil servants based on rank/class, age, length of service, department, and so forth. The way to overcome the availability of data quickly and accurately is to do Business analytical. This process can be done by designing the data warehouse first. The design of data warehouse will be done by dividing it into three tiers of level.

1. Introduction

Fast and accurate information is highly needed in daily life. Information will be an important element in the development of society for today and the future. However, the needs of high information are sometimes not matched by adequate information presentation. Frequently, the information is still to be rededicated from very large-amounted data.

Civil Servant Agency of Regional Training and Education (*Badan Kepegawaian Diklat Daerah* – BKDD) of Minahasa Regency is a governing body for the management of civil servants (*Pegawai Negeri Sipil* - PNS), especially in Minahasa Regency. The main duties and functions of BKDD of Minahasa Regency refer to the activities that are directly related to the processing and analysis of civil servant data in Minahasa. In its implementation, every semester, BKDD of Minahasa Regency usually gives a circular letter to every Regional Instrument Work Unit (*Satuan Kerja Perangkat Daerah* – SKPD), requesting to enter or report the personnel data related to the SKPD. Additionally, if there is any change of the personnel data, the SKPD concerned should re-update the data of BKDD in Minahasa. The data will later be used to fulfill the processing and management tasks of civil servants in Minahasa Regency, one of which is the task of structuring and formatting civil servants (PNS). To carry out the civil servant arrangement and formation, information of the quantity, quality, composition, and distribution of civil servants in the Minahasa region is required. The data held in the institution of BKDD of Minahasa Regency are in very large quantities. Therefore, it takes time and effort to analyze the data in order to obtain the required information. The number of Civil Servants in Minahasa Regency until 2017 has reached more than 6000 civil servants.



This research was conducted to overcome the problems faced by BKDD of Minahasa Regency in analyzing the data that exist. The design of Three-Tier Level Data Warehouse Architecture for the civil servant data in Minahasa Regency was conducted by integrating the data in the form of spread sheet data into the data warehouse using Pentaho data integration-kettle, doing analysis with MDX query using Pentaho scheme workbench, and displaying dashboard using Pentaho BI server plugin sayku analytic. The process above would be divided into three tiers of level: top tier, middle tier, and bottom tier.

2. Research Methods

2.1. Experimental design

The research design that would be conducted in this research is as follows [1][2]:

- a. Bottom-Tier Level, consisting of:
 - 1) Determining the subject of the data warehouse. One of the characteristics of a data warehouse is subject-oriented. Therefore, the first stage in establishing the data warehouse was defining the subject.
 - 2) Defining the needs. It was defined all the needs of data sources required by the data warehouse and the information required to be obtained from the data warehouse to support the management decision.
 - 3) Creating the design of star scheme and designing the process of ETL. Data warehouse generally uses dimensional data model or often called as a star scheme. The star scheme has two parts, namely fact table, and dimension table. Fact table is a table containing the facts of business, generally a table the details of transactions that have occurred [3]. After the scheme was made, the next process was doing the process of ETL (Extraction, Transformation, Loading) from the operational database to the database of the data warehouse. Before the ETL process was conducted, the design for the ETL process was required to be created.
 - 4) Performing the process of ETL from the operational data/database to the data warehouse database. The process of ETL periodically extracts the data from the source system, transforms it to a general format, and then loads it into a target data source, which is generally a data warehouse or data mart. ETL is very important for data integration and data warehousing. In this research, the ETL was done using Pentaho Data Integration.
- b. Middle-Tier Level, in which the researcher created a dimensional data cube for the data warehouse by using MDX-query run on the workbench scheme.
- c. Top-Tier Level, displaying the dashboard by using Pentaho BI server plugin sayku analytic.

2.2. Related research

Here are some research related to the design of three-tier level architecture data warehouse:

- a. Extract transformation loading from OLTP to OLAP data using Pentaho data integration. This research was conducted at the bottom-tier level, explaining in detail the process of ETL by using Pentaho Data Integration [4].
- b. Vertical Information System: A Case Study of Civil Servant Teachers' Data in Manado City [5]. This research used Pentahotool in analyzing and designing the data warehouse on the civil servant teacher data of Manado City.
- c. The Team Study Report of Capital Market and Financial Institution Supervisory Agency (BAPEPAMLK) on the Business Intelligence Implementation of the Finance Ministry of the Indonesian Republic of 2007 [6]. This research was aimed to determine the important aspects that must be understood and prepared in implementing the system of Business Intelligence (BI) in the environment of BAPEPAMLK.
- d. Business Intelligence Application Design on the Distribution Information System of PT Pertamina Lubricant using Pentaho [7]. This research produced BI application by using Pentaho. There were three phases in conducting this research: The first phase was determining the input. The input was

derived from the data that had been recorded in the distribution information system of PT Pertamina Lubricant SR III namely transactional data, master data, and reference data. The second phase was designing the system. In this phase, the input data source would be integrated into one data warehouse through ETL process (Extraction, Transformation, Loading), creating a cube or data mart logically consisting of various data dimensions and fact tables. The third was the process of data analysis, which used an OLAP method.

- e. Library Warehouse Data Design and Manufacture of STIMIK AMIKOM Yogyakarta [8]. This research was made by using SQL Server Integration Service (SSIS) which is a tool for SQL Server 2005. There were 7 stages implemented in this research.
- f. A white paper entitled Microsoft SSIS and Pentaho Kettle: A Comparative Study for Three-Tier Level Data Warehouses [9], explaining the difference between Microsoft SSIS and Pentaho Kettle if viewed from the three-tier data warehouse architecture. This research discusses the difference between the 3 layers namely bottom tier, middle tier, and top tier. However, this research does not emphasize the process and explains the observation of both BI tools in a general way.
- g. A Journal of which title was A Service-oriented Architecture for Business Intelligence [10] discussed comparison between service-oriented concepts in BI and the traditional BI concept. The literature study concluded that with the concept of service-oriented in BI, the process of receiving information and technology integration became more effective compared to doing so with the traditional BI concept

3. Results and Discussion

3.1. Three-tier level data warehouse architecture

A data warehouse is not a product but an environment where users can find strategic information [11]. The data warehouse is a collection of logical data separated from the operational database and it is a summary [8]. According to Poniah [11], a data warehouse is:

- Retrieving all data coming from the operating system.
- If applicable, it includes the relevant data derived from outside (external) such as the indicator of industrial benchmarks.
- Integrating all data derived from all diverse data sources
- Eliminating all inconsistent data and transforming the data
- Storing all data in a format that allows the data to be easily accessible for decision making.

In the design of data warehouse architecture, there are three tiers of a level (three-tier level). The three tiers cover the bottom-tier level, middle-tier level, and top-tier level.

It can be seen from the figure below:

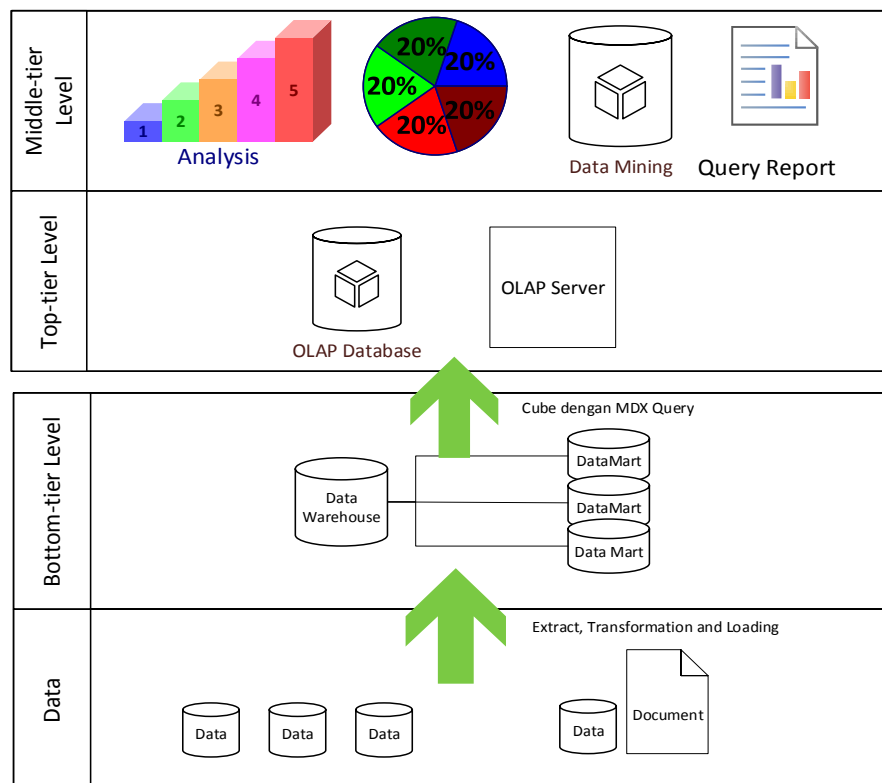


Figure 1. Three-Tier level data warehouse architecture.

3.2. Bottom-tier level

In this research, the design of civil servant data warehouse of Minahasa Regency was created using Open Source Business Intelligence System. To conduct the civil servant structuring and formation, it should be identified the problems occurring in the office of Civil Servant Agency of Regional Training and Education (*Badan Kepegawaian Diklat Daerah – BKDD*) as well as the required and wanted needs. The problems currently faced are the information presentation and data report that are less accurate and qualified, and takes a long time. The data managers find difficulty in sorting and processing the data and obtaining the information needed. This is because the system is inadequate so that, to achieve the needs for the implementation of the civil servant structuring and formation task in Minahasa, it takes a long time. To carry out the structuring and formation of the civil servants (PNS), it needs information for the decision supporting material such as staff distribution (spread) for each SKPD in Minahasa, the number of staffs (civil servants) based on the educational background, the number of positions available in SKPD, the number of staffs distributed [spreaded] based on the position, class, and the echelon level. In its implementation, every semester, BKDD of Minahasa usually gives a circular letter to every Regional Instrument Work Unit (*Satuan Kerja Perangkat Daerah – SKPD*), requesting to enter or report the personnel data related to the SKPD. Additionally, if there is any change of the personnel data, the SKPD concerned should re-update the data of BKDD in Minahasa. The data of the civil servants will later be inputted by each SKPD, then processed in the data processing division to then generate reports and information needed. The data source of civil servants processed by the officers is inputted by each SKPD in Minahasa in the form of excel files with different table format so that the data processing officers experience difficulty in sorting, merging and processing these data. Therefore, the information presentation often meets delays, and it affects the accuracy level of the data.

This stage was made to plan the data warehouse design of the civil servants for the purpose of staff structuring and formation. In this stage, a multidimensional modeling of star scheme was used, as can be seen in the following figure:

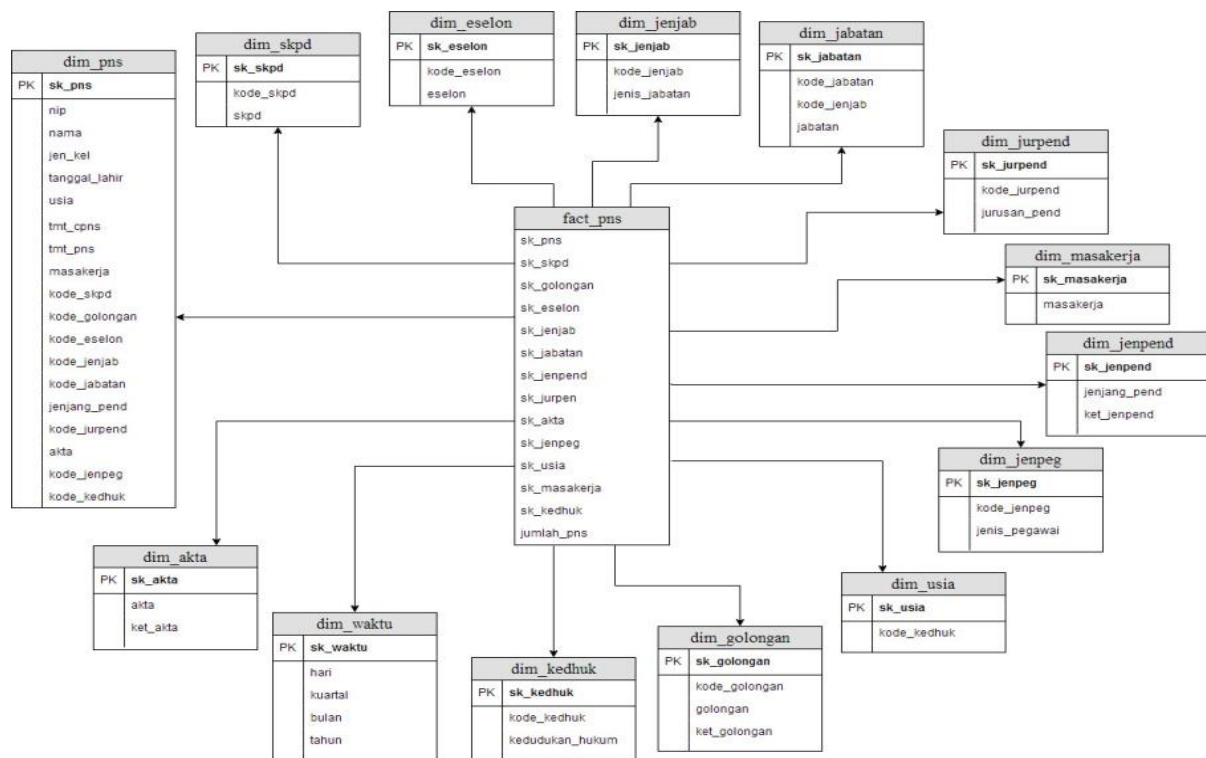


Figure 2. Star schema.

ETL process (Extraction, Transformation, Loading) is a process that must be conducted in establishing data warehouse [2]. In general, the benefits of ETL are as follows:

1. To input data from OLTP to OLAP (data warehouse)
2. To integrate inter-application
3. To clean data
4. To migrate data
5. To export data

As for the process of ETL, it is closely related to data and database sources, including:

1. Extracting data from external sources. The external sources can be in the form of excel, CSV, database, XML, web service, database, etc.
2. Transforming (converting) the data according to the needs (it may include the element of data quality).
3. Loading (inputting) the data into the final target. The final target can be in form of excel, CSV, database, XML, web service, database, etc.

The design of ETL (Extraction, Transformation, Loading) was also created to produce the civil servant data warehouse of *BKKD* of Minahasa Regency. In the process ETL, it was used *Pentaho Data Integration (Kettle)* for the transformation process, which was the real implementation of the star scheme data modelling that had been made previously. The dimension table was one that would establish the civil servant data warehouse of *BKDD* of Minahasa Regency.

3.2.1. Dimension table of civil servants (*dim_pns*). The data source to perform the transformation process of civil servant dimension table was derived from excel data, resulting ***dim_pns***.

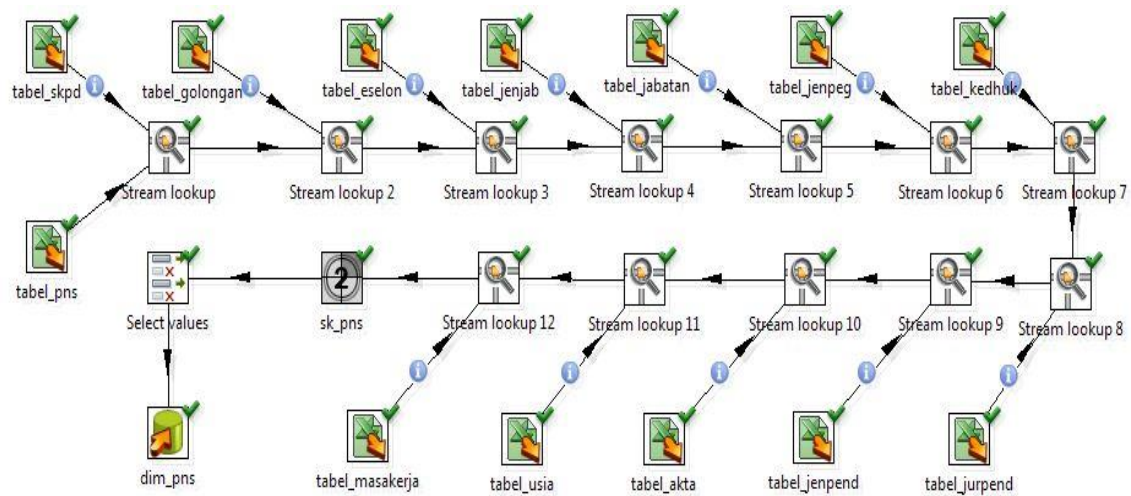


Figure 3. Transformation Process of DIM_PNS.

After the transformation was successfully made, the following table (as can be seen in Figure 4) would be created:

#	sk_pns	NIP	NAMA	JEN_KEL	TANGGAL_LAHIR	USIA	TMT_CPNS	TMT_PNS	MasaKerja	KODE_SKPD
1	1	196902212015102001	REISJE FRYSCHE MANTIRI	P	1969/02/21 00:00:00.000	48	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
2	2	197007142015102001	SRI HARMATY SUPARTO	P	1970/07/14 00:00:00.000	46	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
3	3	197202122015102001	DETTY FRIDA WAURAN	P	1972/02/12 00:00:00.000	45	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
4	4	197203042015102001	GRACE MEITA WOY	P	1972/03/04 00:00:00.000	45	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK000
5	5	197208102015102001	ESTER NAOMI SWITA PAKASI	P	1972/08/10 00:00:00.000	44	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
6	6	197302122015102001	IVONNE SORONGAN	P	1973/02/12 00:00:00.000	44	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
7	7	197304122015102001	MARLENDIA ANNEKE RORING	P	1973/04/12 00:00:00.000	44	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
8	8	197401082015102001	NORICE RUJAW	P	1974/01/08 00:00:00.000	43	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
9	9	197711092015102001	SERVIANA STERY KOLONDAM	P	1977/11/09 00:00:00.000	39	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
10	10	197802132015101001	FATLY PESIK	L	1978/02/13 00:00:00.000	39	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
11	11	197805252015101001	MELKY VADLY WOWOR	L	1978/05/25 00:00:00.000	39	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
12	12	197809112015102001	OLEYVE MERCY SUMAMPOUW	P	1978/09/11 00:00:00.000	38	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
13	13	197902272015102001	FELMA WESTI MANANGKA	P	1979/02/27 00:00:00.000	38	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK000
14	14	198108162015102001	IMELDA WOKAS	P	1981/08/16 00:00:00.000	35	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
15	15	198207102015102001	MAYA IVONNE YULITA LUMANAUW	P	1982/07/10 00:00:00.000	34	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK019
16	16	198305242015102001	MAYA MERLINA JUWITA PONAMON	P	1983/05/24 00:00:00.000	34	2015/10/01 00:00:00.000	2016/10/01 00:00:00.000	1 tahun, 7 bulan	UK000
17	17	196003152015092001	JEANE S SANIMAN	P	1960/03/15 00:00:00.000	57	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
18	18	196105302015092001	MATRESSE LOHO	P	1961/05/30 00:00:00.000	55	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
19	19	196008282015091001	JOOST H LUMINGKEWAS	L	1960/08/28 00:00:00.000	56	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
20	20	196207192015091001	GUSTAAF ADOLF TANBOWAS	L	1962/07/19 00:00:00.000	54	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
21	21	196306032015092001	JENNY BARNETJI JULIANA SUMUAL	P	1963/06/03 00:00:00.000	53	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK010
22	22	196312292015092001	DEYSCIE TALUMEWO	P	1963/12/29 00:00:00.000	53	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
23	23	196403022015092001	MARYKE ELISABETH MANDAGI	P	1964/03/02 00:00:00.000	53	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
24	24	196510012015092001	MARIA MONTECARLO SIKTEUBUN	P	1965/10/01 00:00:00.000	51	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
25	25	196501262015092001	KETLIEN EFLIEN KILING	P	1965/01/26 00:00:00.000	52	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
26	26	196512202015092001	EMMA FRIEDA TUMOBOK	P	1965/12/20 00:00:00.000	51	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
27	27	196605042015092001	MEIKE CHRISTINA UWAY	P	1966/05/04 00:00:00.000	51	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
28	28	196607032015091001	JULIUS CRISTIANO HENDRICO BOTU	L	1966/07/03 00:00:00.000	50	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019
29	29	196801152015092001	JENBMA SUJATAN	P	1968/01/15 00:00:00.000	49	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK000
30	30	196803202015092001	KEEL DIA TAJAIAI MUA	L	1968/03/20 00:00:00.000	49	2015/09/01 00:00:00.000	2016/09/01 00:00:00.000	1 tahun, 8 bulan	UK019

Figure 4. Data Preview of DIM_PNS.

3.2.2. Dimension table of SKPD (*dim_skpd*). The data source to perform the transformation process of the dimension table of SKPD was derived from excel data, resulting **dim_skpd**.

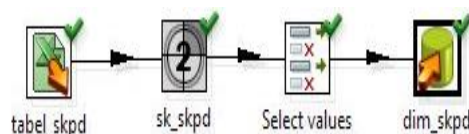


Figure 5. Transformation Process of DIM_SKPD.

After the transformation process was successfully performed, the following table would be created (as can be seen in Figure 6 below):

#	sk_skpd	KODE_SKPD	SKPD
1	1	UK000	(tanpa_ket)
2	2	UK001	BADAN KELUARGA BERENCANA, PEMBERDAYAAN PEREMPUAN DAN PERLINDUNGAN ANAK
3	3	UK002	BADAN KEPEGAWAIAN DAN DINLAT DAERAH
4	4	UK003	BADAN KESATUAN BANGSA, POLITIK DAN PERLINDUNGAN MASYARAKAT
5	5	UK004	BADAN KETAHANAN PANGAN
6	6	UK005	BADAN LINGKUNGAN HIDUP
7	7	UK006	BADAN PELAKSANA PENYULUH PERTANIAN, PERIKANAN DAN KEHUTANAN
8	8	UK007	BADAN PEMBERDAYAAN MASYARAKAT DAN PEMERINTAHAN DESA
9	9	UK008	BADAN PENANAMANAN MODAL
10	10	UK009	BADAN PENANGGULANGAN BENCANA DAERAH
11	11	UK010	BADAN PERENCANAAN PEMBANGUNAN, PENELITIAN DAN PENGEMBANGAN DAERAH
12	12	UK011	DINAS ENERGI DAN SUMBER DAYA MINERAL
13	13	UK012	DINAS KEHUTANAN
14	14	UK013	DINAS KEPENDUDUKAN DAN CATATAN SIPIL
15	15	UK014	DINAS KESEHATAN
16	16	UK015	DINAS KOPERASI, USAHA KECIL DAN MENENGAH
17	17	UK016	DINAS PARAWISATA DAN KEBUDAYAAN
18	18	UK017	DINAS PASAR DAN KEBERSIHAN
19	19	UK018	DINAS PEKERJAAN UMUM
20	20	UK019	DINAS PENDIDIKAN, PEMUDA DAN OLAHRAGA
21	21	UK020	DINAS PENGELOLAH KEUANGAN, ASSET DAN PENDAPATAN
22	22	UK021	DINAS PERHUBUNGAN, KOMUNIKASI DAN INFORMATIKA
23	23	UK022	DINAS PERIKANAN DAN KELAUTAN
24	24	UK023	DINAS PERINDUSTRIAN DAN PERDAGANGAN
25	25	UK024	DINAS PERTANIAN, PETERNAKAN DAN PERKEBUNYAN
26	26	UK025	DINAS SOSIAL
27	27	UK026	DINAS TENAGA KERJA
28	28	UK027	INSPEKTORAT
29	29	UK028	KANTOR PELAYANAN PERUMAHAN TERPADU
30	30	UK029	KANTOR PERPUSTAKAAN, DOKUMENTASI DAN ARSIP DAERAH

Figure 6. Data Preview of DIM_SKPD.

3.3. Middle-tier level

In the middle tier, we used OLAP Server in which a multidimensional OLAP modelling can be implemented, executing directly the multidimensional data and operations. In this stage, a cube design – a process of creating data modelling logically from one dimension to be multi dimensions – was done. In generating graphs that can be viewed from various dimensions, it needed a process of *MDX Query* by using scheme workbench application.

The process of creating *MDX Query* of the civil servant data scheme on the application of GUI-*Scheme Workbench* containing **dataPNS_cube** and dimensions that have been made such as **dim_pns**, **dim_skpd**, **dim_jabatan**, **dim_jenjab**, **dim_jenpend**, **dim_jurpend**, **dim_kedhuk**, **dim_jenpeg**, **dim_usia**, **dim_masakerja**, **dim_akta**, **dim_golongan**, **dim_eselon**, **dandim_waktu**. The resulted *Scheme Workbench* can be seen in Figure 7 below:



Figure 7. Scheme of Civil Servant Data (DATAPNS) using Workbench Application.

The OLAP data were hierarchically organized and stored in *the cube*. In the dimension of **dim_pns** on the scheme of **dataPNS**, there was a hierarchy of **pns** (civil servants) containing several levels *i.e.* **nama**, **jenis_kelamin**, **tanggal_lahir**, **tmt_cpns**, **tmt_pns**, **dantabeldim_pns**. **Hirarkidalamdim_pns** as can be seen in Figure 8.

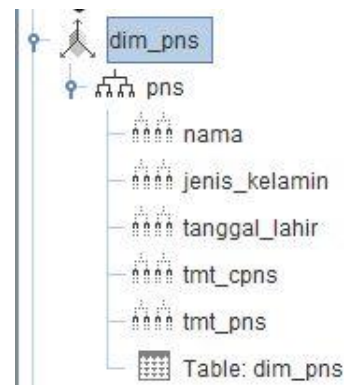


Figure 8. Hierarchy of DIM_PNS.

3.4. Top-tier level

These results were formed from the *MDX Query* on *cube* design that would display charts, diagrams, and tables in the *dashboard reporting*. To display the *dashboard* on the panel server *Pentaho BI*, plugins of *Saiku Analytics* was used for the analysis view results. Here are some *reporting* view results using *Saiku Analytics*:

A *dashboard* on the number of civil servants based on the level of education is shown in Figure 9 below.

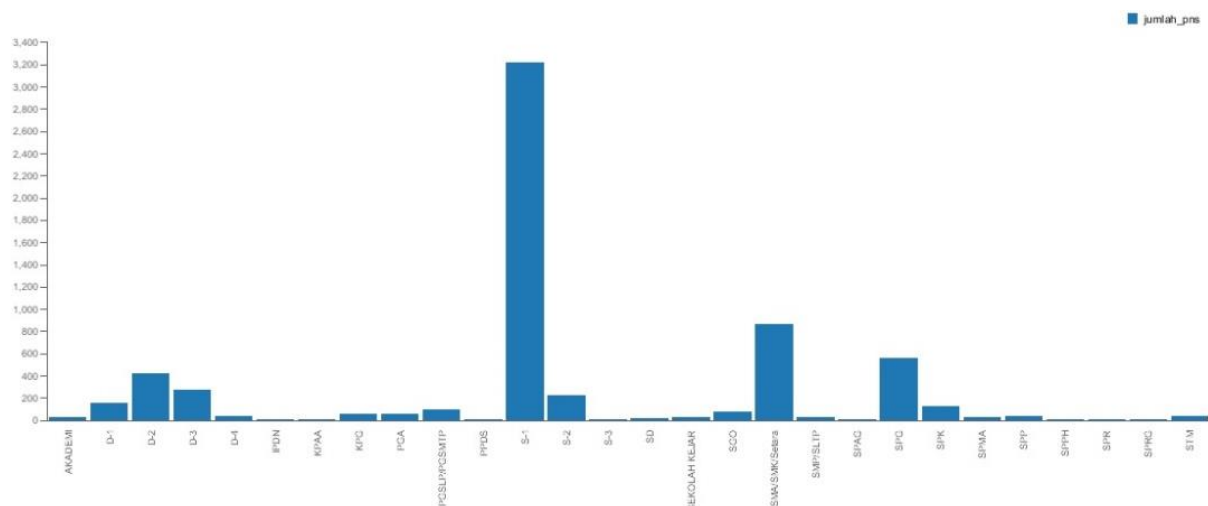


Figure 9. Bar Graph to See the Number of Civil Servants Based on Educational Background Level

Figure 10 below shows the *dashboard* for the number of civil servants based on the major or department (study program) of education in *SKPD* of Tondano Barat District.



Figure 10. Pie Graph on The Number of Civil Servants Based on The Study Program Filtered for SKPD of Tondano Barat.

4. Conclusion

Based on the results of the research conducted in designing a Three Tier Level Architecture in the Civil Servant Data Warehouse of Minahasa Regency using Open Source Business Intelligence System, it can be concluded: data warehouses with the use of Pentaho Open Source application can be created easily and quickly, and free of cost; the design of data warehouses using Open Source Business Intelligence System in Minahasa Regency will helpfully support the government in making a decision for the civil servant structuring and formation held at the office of BKDD of Minahasa. For the report, it can be presented through a dashboard in the form of multidimensional graphs in accordance with the required information; by the existence of civil servant data warehouses using Business Intelligence System, the reporting or presentation of information for the requirement of civil servant structuring and formation task will not experience the problem of delays or will not take a long time to get the required information.

Acknowledgments

We would like to thank *Lembaga Penelitian dan Pengabdian Masyarakat (LPPM)* and Engineering Faculty Universitas Negeri Manado for supporting the research.

References

- [1] Moss L T and Atre S 2003 *Business intelligence roadmap: the complete project lifecycle for decision-support applications* Addison-Wesley Professional
- [2] R Kimball and J Casertan 2015 *The Data Warehouse ETL Toolkit* **1**
- [3] J Mulyana 2014 *Pentaho: Solusi Open Source untuk Membangun Data Warehouse* (Yogyakarta: ANDI)
- [4] R J Salaki, J Waworuntu and I R H T Tangkawarow 2016 Extract transformation loading from OLTP to OLAP data using pentaho data integration *IOP Conf. Ser. Mater. Sci. Eng.* **128** 12020
- [5] J P A Runtuwene and I R H T Tangkawarow 2017 Vertical information system: A case study of civil servant teachers data in Manado city *Indones. J. Electr. Eng. Comput. Sci.* **6** 1 42–49
- [6] Tim Studi Implementasi Business Intelligence 2007 *Laporan tim studi tentang implementasi business intelligence (Departemen Keuangan Republik Indonesia Badan Pengawas Pasar Modal Dan Lembaga Keuangan)*
- [7] R W Witjaksono, M Wiyogo, and P N Wicaksono 2007 Perancangan Aplikasi Business

- Intelligence Pada Sistem Informasi Distribusi Pt Pertamina Lubricant Menggunakan Pentaho
J. Rekayasa Sist. dan Ind. **2** 2 12–18
- [8] A Armadyah 2009 Perancangan Dan Pembuatan Data Warehouse Pada Perpustakaan STMIK AKAKOM Yogyakarta *Tesis. Perpust. MTI* 39–52
- [9] Grecol M L 2012 *Microsoft SSIS and Pentaho Kettle: A Comparative Study for Three-Tier Data Warehouses*
- [10] Wu L, Barash G, and Bartolini C 2007 A service-oriented architecture for business intelligence *Service-Oriented Computing and Applications, 2007. SOCA'07. IEEE International Conference on* 279-285 IEEE
- [11] P Ponniah 2001 *Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals*