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BUILDING DATA MARTS IN TEACHING MANAGEMENT: A CASE STUDY

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Abstract

This research is a series of researches with the theme Smart-Pusdiklat in the environment of State Cyber and Crypto Agency (BSSN). The locus chosen is the Human Resources Development Center) which is a subset of BSSN. Pusbang is a supporting element of the duties and functions of BSSN, which has the task of carrying out functional position coaching, and developing human resource competencies in the field of cyber security. The research question expressed is how to make leaders at Pusbang and stakeholders can make more comprehensive and fast decisions in managing institutions with the help of data warehouses. The researcher conducted a projection to build a data warehouse, which was then focused on becoming a specific data mart, and explained how users could access it for teaching management purposes at Pusbang. This research uses exploratory research methods with a qualitative approach. This method is intended to try a new phenomenon that may not have been before. This is the novelty value of this study. Researcher project the construction of 4 (four) data marts, namely JFKamsiber, References, Lecturer profiles,

and Alumni data mart. Where this can make it easier for users to analyze, report and mine data in teaching management.

Keywords:

Data Warehouse, Data Mart, Teaching Management, Information Systems, Decision Making

1. Introduction

Research on the transformation of educational technology in the context of data warehouses in educational institutions has been carried out a lot. Some of them are by Santoso et all from Petra Christian University (Santoso & Yulia, 2017), Youssef Bassil from the Lebanese Association for Computational Sciences (Bassil, 2012), and Shirin Mirabedini from Payame Noor University, Tehran (Mirabedini, 2014).

Meanwhile, similar research recorded transforming educational technology in the context of data warehouses in educational institutions with case studies at the Center for Human Resource Development for State Cyber and Crypto Agency (*locally known as Badan Siber dan Sandi Negara or "*BSSN") does not exist yet. So, this is the first opportunity for researcher to conduct similar research. However, this research is inseparable from previous research at the BSSN Pusdiklat. Like the previous journal entitled "Smart-Pusdiklat: Projection of Scenario Building and Planning Model in the Transformation of Pusdiklat Lemsaneg into Pusdiklat BSSN" (Suprijandoko, 2020). For the record that the nomenclature of the Education and Training Center (*locally known as Pusat Pendidikan dan Pelatihan or "*Pusdiklat") has changed its name to the Human Resource Development Center hereinafter referred to as Pusbang *(locally known as Pusat Pengembangan Sumber Daya Manusia or "Pusbang")*, and the State Cyber and Crypto Agency hereinafter referred to as BSSN regulations (BSSN Regulations No. 6, 2021).

In the journal (Suprijandoko, 2020) there are strategic milestones explained with 4 (four) pillars and the phasing of termin per termin. The pillars chosen are the Organizational Pillar, Human Resources Pillar, Regulatory Pillar, and Technology Pillar (Prastyo B Army in (Suprijandoko, 2020)). One of the items in the 2022 termin is the Education item. Researcher describe it in the form of a data warehouse for teaching management purposes at Pusbang.

For teaching management purposes, a data warehouse is designed by researcher to build a data mart. Why is the existence of a data warehouse so important? Especially for an educational institution such as Pusbang. It is because of the ability of the data warehouse to store large amounts of information. Then, the records and all past activities will be neatly stored. If there is a change

in data, or new data appears, the data warehouse will also store it neatly. The data is easy to integrate, and it is also easy to analyze well. So, it is easy to use as a basis for decision making (Santoso & Yulia, 2017).

In fact, integrated data will greatly facilitate the process of data retrieval, data collection, and data analysis for fast decision making. The non-volatility aspect ensures that the data in the data warehouse is accurate and reliable. This can guarantee the leadership of the institution in making decisions (Subrahmanyam & Doja, 2008) (Subrahmanyam & Doja, 2011) (Yu, 2021)

So, the advantages of building a data warehouse are subject-oriented data, integrated data, non-volatility data, and time variants (Han et al., 2012) (Oracle, 2022). Of course, the advantages of building a data warehouse will be maximized if the data warehouse gets data input from various valid and relevant sources. For this study, the main data source in the data warehouse is the Pusbang database itself, which can then be combined with other data sources coming from pusbang (Data Center and ICT, locally known as Pusat Data, dan Teknologi Informasi dan Komunikasi or "Pusdatik") and OSDM (Bureau of Organization and Human Resources locally known as Biro Organisasi dan Sumber Daya Manusia or "OSDM") at Figure 1.

Then in the Staging Area, the incoming data from the source data will pass through the ETL process (extract, transform, and load) so that it transforms into quality data (Dharayani et al., 2015). All-important data must be available before it can be entered into the data warehouse (Varshney, 2022). In the end, users can use the selected data for analysis, reporting and data mining purposes. Of course, this service will be easier with the presence of data mart. At least 5 (five) reasons for using data mart are recorded, namely data mart contains data from all work units, divided into single subject areas, limited data sources, limited memory usage, and less time to deploy.

The presence of data mart services at Pusbang is solely to facilitate teaching management. Considering that quadrant-fourth which is the best scenario for Pusbang has not been implemented (Suprijandoko, 2020), this learning concept is a bit slow to implement. This is also indicated by the slow branding management process, where Pusbang must refer to the BSSN branding (Suprijandoko, 2017).

2. Methodology

The research method is a step in collecting, organizing, analyzing and interpreting data. According to Sugiyono (Sugiyono, 2018) in general the research method is defined as a scientific way to obtain data with specific purposes and uses. Research questions should be raised. as well as Research Methods, Research Objectives, Locus and Object of Research, and Data Collection Techniques.

2.1. Research Questions

The research question expressed is how to get leader in Pusbang and stakeholders to make more comprehensive and quick decisions in managing institutions with the help of data warehouse. The researcher conducted a projection to build the data warehouse to focus on becoming a specific data mart, and explained how users can access it for teaching management purposes at Pusbang.

2.2. Research Methods

Research methods are a scientific way to obtain data with a specific purpose and uses (Sugiyono, 2018). This involves various kinds of collecting, analyzing, and interpreting data that researchers put forward in their research work (Creswell, 2014). In accordance with these objectives, the approach in this study uses the exploration research method with a qualitative approach. exploratory research methods, according to Asropi (Asropi, 2016). This is a study intended to try a new phenomenon that may not have existed before. In this study, a qualitative approach was used, which makes claims to constructive and transformative knowledge.

2.3. Research Objectives

Researcher discuss projections of designing a data warehouse. Where the data source comes from 3 (three) sources and ends up being 4 (four) data marts. The 3 (three) data sources come from Pusbang, Pusdatik, and OSDM. While the 4 (four) of data marts are JFKamsiber, References, Lecturer profiles, and Alumni Data mart.

2.4. Locus and Object of Research

The locus of research is in Pusbang, while the object studied is a projection of building 4 (four) data marts

2.5. Data Collection Techniques

Data collection is the most strategic procedure in research, because the main purpose of research is to obtain data (Sugiyono, 2018). This study collected 2 (two) types of data, namely

primary data and secondary data. Primary data is data obtained directly from the source without intermediaries. While secondary data is data taken indirectly from the source. This study used several data collection techniques, namely:

2.5.1. Document Review, which is interpreted as an attempt to obtain data and information in the form of written records or images stored with the problem under study. At first, researcher experienced problems in obtaining documents. Considering that the BSSN Enterprise Architecture Design cannot be accessed by researcher. Where the data should be spread and become a discussion material for all work units. The design data was only able to be studied in the Data Warehouse Training class a few months ago.

2.5.2. Observation, is a technique that requires the researcher to plunge directly into the locus of research. To obtain data, review the required data, and obtain information regarding the condition of the object under study. In this study, observations were carried out since the beginning of 2017, where the researcher officially became a citizen of Pusdiklat (Suprijandoko, 2017) which later changed its name to Pusbang (BSSN Regulations No. 6, 2021). There are visible difficulties in coordinating and synchronizing data in development and planning scenarios. More effort is needed to create a "leadership dashboard" (Suprijandoko, 2020).

2.5.3. Semi-Structured Interviews, are data collection techniques used by researcher to find out something more in-depth. Interviews were conducted by asking questions orally to several speakers in the data warehouse training class, interviews with simulations were conducted to obtain information about how the flow of data in the data warehouse architecture design according to Figure 1. Instructors provide insights and develop into productive discussions.

3. Results and Discussion

Researcher are designing a functional data warehouse according to Figure 1. The data flow can be simulated starting from 3 (three) data sources, namely 2 (two) data operational systems which are from Pusbang and Pusdatik, and 1 (one) flat file data comes from OSDM.

What is an operational system? Operational system is a term commonly used in data warehouse. It refers to the system used in the process of daily transactions in an organization. The system is designed in such a way that the processing of such transactions is carried out efficiently and maintains the integrity of transactional data.

Thus, Pusbang operational system is a system that refers to the daily data process transacted from-and-to Pusbang. In accordance with (BSSN Regulations No. 6, 2021) Article 110, Pusbang has the task of carrying out the development of functional positions and the development of human resource competencies in the field of cybersecurity. More details can be in the form of office administration data, annual planning data, semester and quarterly actualization. It can also be training data, students, widyaiswara (lecturers), and alumni. (Duran-Dominguez et al., 2018; Syed Badrul Hisham et al., 2020) Then it can also be information technology infrastructure data, such as hardware and software and the licenses that come with it.

While Pusdatik operational system (BSSN Regulations No. 6, 2021) in accordance with Article 104 has the task of planning, implementing, evaluating, and reporting in the field of data and communication information technology. Where there is one of the projection programs in the form of the One Data BSSN Program which is a subset and supports the One Data Indonesia program.

OSDM flat files data (BSSN Regulations No. 6, 2021) is indeed indispensable. In accordance with Article 14 which has the task of carrying out guidance and structuring of organizations and governance, as well as coaching and implementing human resource affairs.

Then according to Figure 1, starting from data sources, the data will move to the staging area. Where the data copied from the source will be stored temporarily. On the staging area architecture, most of the data is based on time considerations. In other words, before that data can be put into the data warehouse, all important data must first be properly available. It is almost said that it is not possible to retrieve all data from all operational databases at the same time. Given the many things to consider, such as considerations for business cycles, data processing cycles, hardware, computer network infrastructure, and geographical variables. (Varshney, 2022)

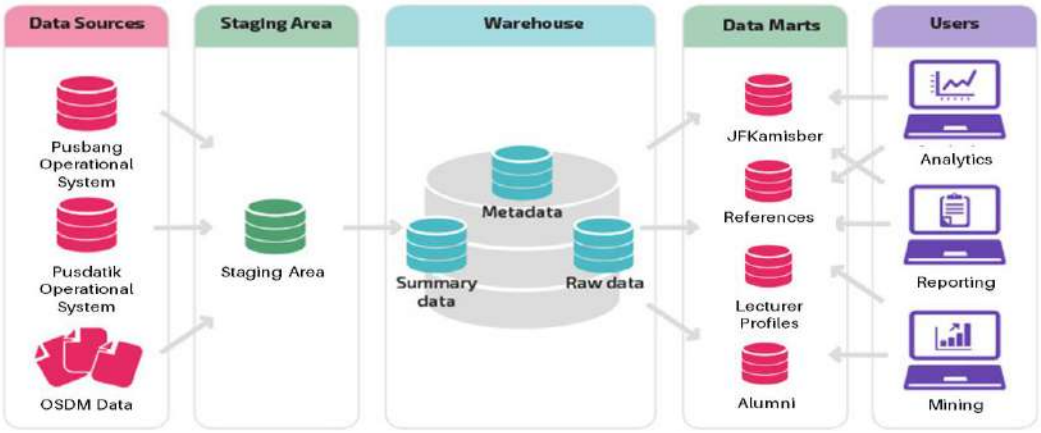

Figure 1: *Data Warehouse Architecture*

(Source: Self)

Then the data flows into the data warehouse. Data warehouse is a type of data management system designed to support business intelligence activities. The main thing is data analytics. It is intended to perform queries and analysis, and often contains large amounts of historical data.

There are several parameters that can be measured in the data warehouse (Table 1), namely the data warehouse which has a large data size. Sourced to more than one data source. The data sources come froma variety of sources. Such as application logs and application transactions. The location of the data center must be in place of data consolidated from various locations. With so many databases, it is certain that there will be a variety of subjects that can be managed by the data warehouse. Data warehouse uses a large enough memory to process data. It is usually quite time-consuming in implementing it.

So, if there is a question, why should you use a data warehouse? The answer is because in a data warehouse, all data can be collected from a variety of valid and relevant sources. Then the data that has been collected cannot be directly visualized by the user. Instead, the data must first be integrated and processed before visualization.

Table 1: *Data Warehouse vs Data mart*

Parameters	Data Warehouse	Data mart
Size of data	Enterprise-wide data	Department wide data
Subject of area	Mulitple subject areas	Single subject area
Data sources	Multiple data sources	Limited data sources

Memory	Occupies large memory	Occupies limited memory
Time to implement	Longer time to implement	Shorter time to implement

(Source: Oracle, 2022)

Users can directly get data from the data warehouse. However, there are solutions that can make analytics, reporting and mining jobs easier, namely, by using data mart.

What is Data Mart? Data mart is a smaller version of data warehouse, which deals with only one subyek area. Very specific and focused on one subject only. The time it takes to build a data mart can be faster when compared to the time it takes to build a data warehouse.

There are 3 (three) types of data marts, namely Dependent, Independent, and Hybrid data mart. Researcher choose to use Dependent data mart. The point of Dependent is the data is first extracted from the OLTP (online transaction processing) systems and then populated the central data warehouse. Then from data warehouse, the data travels to the data mart. (Oracle, 2022)

According to Figure 1, the researcher designed 4 (four) proposed data marts, namely JFKamsiber, References, Lecturer profiles and Alumni data mart. JFKamsiber's data mart is intended to provide information about the Cybersecurity Functional Position. Pusbang has an obligation to carry out functional position coaching and competency development of cybersecurity human resources. (BSSN Regulations No. 6, 2021)

Then, Lecturer Profiles's data mart will provide complete data on teachers, such as competency specialties, teaching experience, research, awards, teaching track record, and active in social roles to the community. The Alumni's data mart contains information on Alumni who have graduated from all trainings organized by Pusbang based on the National Occupation Map of Cybersecurity. This is a strategic reference for the development of Indonesian human resources, the establishment of an HR certification ecosystem in the field of cybersecurity, as well as part of the national cybersecurity incident mitigation strategy. (Indonesian MNDP, 2019) Last but not least.

The Users. Users are all BSSN employees can access all existing data marts. Of course, it must be limited and in accordance with its role and responsibility. (Suprijandoko, 2018)

Who else can access it? Are the Leaders in other Ministries and Institutions, who are restricted and in accordance with existing laws and regulations. Of course, this is a form of service for providing public information, and limited information from Pusbang to Stakeholders. The users are given a role and responsibility and are always strictly evaluated. They can access it whenever

the information is needed. Researcher made it divided into 4 ways (Figure 2). for Users to access the data mart

Users have 4 (four) choices according to roles and responsibilities in order to access the data mart. The four options are **First**, Users can access it locally by entering the Pusbang local network which is a subset of the BSSN network. Users can analyze the data in the data mart. Also, users can take it as specific report material. Then the user can also the existing data.

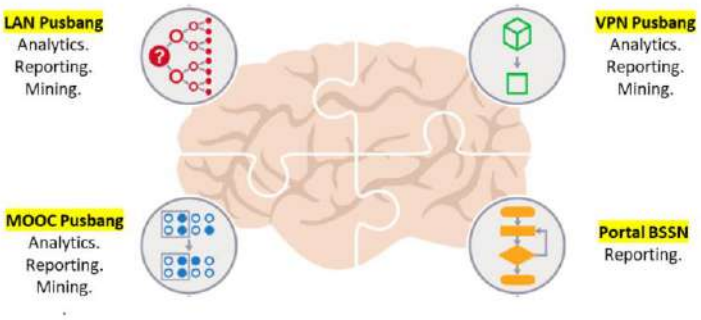

Figure 2: *How Users Can Access Data Mart*

(Source: Self)

The second option is that users who are outside the Pusbang network, can be given access through a VPN account. Users can do data analytics, reporting and mining. **The third** option is that users can access data marts through the MOOC Pusbang services. The MOOC is Massive Open Online Course. Researcher will submit a proposal to Pusbang so that the MOOC is enriched with data mart features. **Finally, the fourth** option is that Users can access data marts through the BSSN Portal. The services provided are only limited to reporting only.

It was informed to us that in the future Pusdatik will initiate the presence of the One Data BSSN program. Where all work units are required to provide their public data to fill the slots given according to the parameters by Pusdatik. After that, BSSN will take its role and be present in the Satu Data Indonesia program. Where public information about cybersecurity processed by BSSN can be enjoyed by all parties through the One Data Indonesia Portal. (Indonesian MNDP, 2021)

4. Conclusions, Limitations, and Future Research

A data warehouse is a type of data management system designed to support business intelligence activities, especially data analytics. It is intended to perform queries and analysis.

Which often contains a large amount of historical data, considering that the data collected cannot be visualized directly by the User. On the other hand, the data must first be integrated and then processed before being visualized. So, the solution offered is to use a data mart.

There are at least 5 (five) reasons why to use a data mart. Which are, data marts contain data from all work units, data marts are divided into one subject area, data marts have limited data sources, data marts use limited memory, and implementation of data marts is faster to implement. (Oracle, 2022)

Researcher designed 4 (four) Data Mart proposals, namely JFKamsiber Data Mart, Reference Data Mart, Lecturer Profile Data Mart, and Alumni Data Mart. (BSSN Regulations No. 6, 2021) Users will take advantage of data marts in terms of data analysis, reporting and mining. Last but not least, BSSN has an obligation to attend and play a role in government programs through the Satu Data Indonesia Portal. (Indonesian MNDP, 2021)

This research still has some limitations. First, there is no policy for collaborative use of data through Data Warehouse technology. The data is still distributed in different departments and has not been indexed properly. (Golfarelli et al., 2000; Narasimhan, 2014; Rizzi & Saltarelli, 2003) Second, there is no decision by the Head of the HR Center regarding policies on the use of data mining for decision-making purposes. (Asif et al., 2017; D'Oca & Hong, 2015; Romero & Ventura, 2020)

The next research projection is to focus more on the data integration process using the ETL procedure, which stands for Extract, Transform, and Load. This is one of the processes that can help us at HR Center to carry out data governance. Data can be collected and compiled easily. No more groping in the dark. So that leadership decisions can be taken immediately. (Dharayani et al., 2015; Gusti Ngurah Agung Trisna Putra et al., 2020; Narasimhan, 2014; Warnars, 2009)

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