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Business Intelligence Based on Kimball Nine-Steps Methodology for Monitoring the Feasibility of Goods in Market

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ABSTRACT

Consumer protection is of great concern to the Government of Indonesia through the supervision of goods on the market by the Department of Industry and Trade in each province. The Bali Provincial Office of Industry and Trade has transactional data from various data sources but has not been able to optimize it to support monitoring of goods circulating in the market. This research designs and implements a Data Warehouse-based Business Intelligence system using the Kimball Nine-Steps Methodology and Pentaho BI tools, to facilitate the storage and processing of goods data on the market, and monitor their feasibility. The results of this research show that the system can assist the Bali Province Industry and Trade Office in monitoring the feasibility of goods circulating in the market through the selection process for determining query priorities and query modes, as well as supporting decision-making processes and determining business strategies.

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1. INTRODUCTION

Indonesia, the Law Number 8 of 1999 concerning Consumer Protection is a law that guarantees legal certainty and legal protection for consumers, consumer rights, and MSME actors as well as being a strong legal basis for the government and non-government protection agencies, to make efforts to empower consumers through consumer education [1]. In addition, the role of the government regarding consumer protection is also carried out through agencies in the form of the Department of Industry and Trade in each province, which is under the Ministry of Trade of the Republic of Indonesia[2]. Department of Industry and Trade has to supervise and handle all activities related to industry and trade at the regional or provincial level, which are connected to domestic and foreign transactions. In addition, Department of Industry and Trade also oversees the goods circulating in the market.

The Bali Provincial Office of Industry and Trade is located in Denpasar City. The Bali Provincial Office of Industry and Trade has transaction data from various data sources and in several different formats. These data sources come from web-based information systems, desktop applications, mobile applications, and spreadsheet files. These data are processed to produce information, but with limited use, so they cannot be optimized further for the needs of data analysis, assisting in decision making, and determining strategies and policies related to the feasibility of goods on the market to protect consumers and businessmen. It is necessary to have a system that can accommodate, manage, process, and process this data so that it can assist the Bali

Industry and Trade Office in conducting supervision regarding the feasibility of goods on the market.

Based on the background problems, in this research, the design and implementation of a Data Warehouse-based Business Intelligence (BI) system was carried out, using the Kimball Nine-Steps Methodology and the Pentaho BI tool. The formulation of the problem in this research is 1.)How to implement the Kimball Nine-Steps Methodology in the Business Intelligence system that is built, 2.) How does the Business Intelligence system assist in the decision-making process.

There are eight previous pieces of research related to Business Intelligence in several case studies. The first research implements Data Warehouse-based Business Intelligence using Extraction, Transformation, Loading (ETL), and Google Studio in hospitals to improve health services with six parameters, namely Bed Occupancy Rate (BOR), Turn Over Interval (TOI), Average Length of Stay (ALOS), Bed Turn Over (BTO), Net Death Rate (NDR), and Gross Death Rate (GDR)[3]. The results showed that the average parameter gave the highest value indicating that the quality of health services was good. The second research describes the application of a Business Intelligence-based system in hospitals for medical record data, to improve services and support the quality of public services, which is tested using the Black Box Testing method [4]. The results of the research show that the system can improve the quality of public services for health in hospitals, following the minimum service standards. The third research discusses the application of Business Intelligence in the pharmacy department at the Health Service to assist operations and decision-making [5]. The results of the research show that the system built can improve the quality of decisions made based on data to solve problems related to clinical drug needs, operational activities, information needs, and data management effectively. The fourth research concerns the implementation of Microsoft Power BI-based Business Intelligence to assist the decision-making process in Peruvian companies accompanied by reports and graphs [6]. The results showed that the system built was able to support the company in presenting complete data, extracting tables and relations, as well as statistical graphs that are easy for users to understand.

The fifth research describes the process of implementing Data Warehouse-based Business Intelligence in Micro, Small, and Medium Enterprises (MSMEs) using the On-Line Analytical Processing (OLAP) method[7]. The results of the research show that the system developed has succeeded in helping MSMEs to obtain recommendations regarding business trends and the resulting turnover along with the types of businesses that are already running. The sixth research discusses the implementation of Business Intelligence at airports to help study passenger flight patterns at the time of departure and arrival [8]. The results show that the system can help learn the largest number of flights at a time as well as passenger departures and arrivals, to help obtain patterns and information related to business strategy and goals. The seventh research describes the implementation of Tableau-based Business Intelligence in maternity clinics to help manage and analyze delivery data to improve the quality and effectiveness of clinical services [9]. The results of the study show that the system can help clinics to study birth trends that occur, namely total births per semester, time of birth, and the lowest birth rate. The eighth research discusses the implementation of Business Intelligence to assist universities in determining scholarship recipient students, by utilizing the On-Line Analytical Processing (OLAP) and Tree Decision methods as well as the Rapid Miner tool[10]. The results of the research show that the system can assist in forming decision trees related to awarding scholarships to students appropriately.

Of these previous researches, no one has used the Kimball Nine-Steps Methodology and the Pentaho BI Tool in a case study at the Bali Industry and Trade Office in conducting supervision regarding the feasibility of goods on the market. Thus, this research focuses on the use of these methodologies and tools to solve problems that occur in case studies as a contribution to this research.

2. RESEARCH METHOD

2.1. Flowchart

The research flowchart shows the sequence of steps in the research. In this research, the sequence of steps starts from problem analysis, namely analyzing the problems that occur in the

case study site. The data gathering is carried out to collect data from a number of data sources. Then do the data modeling to do the modeling in the form of multi-dimensional data. Furthermore, the data processing and uniformity process is carried out using the Extraction, Transformation, and Loading (ETL) method. Business Intelligence is implemented using Pentaho Business Intelligence (BI) tools. Testing is carried out on the system and then the results are analyzed. Finally, documentation and publication of research results are carried out. The flowchart of this research is shown in Figure 1.

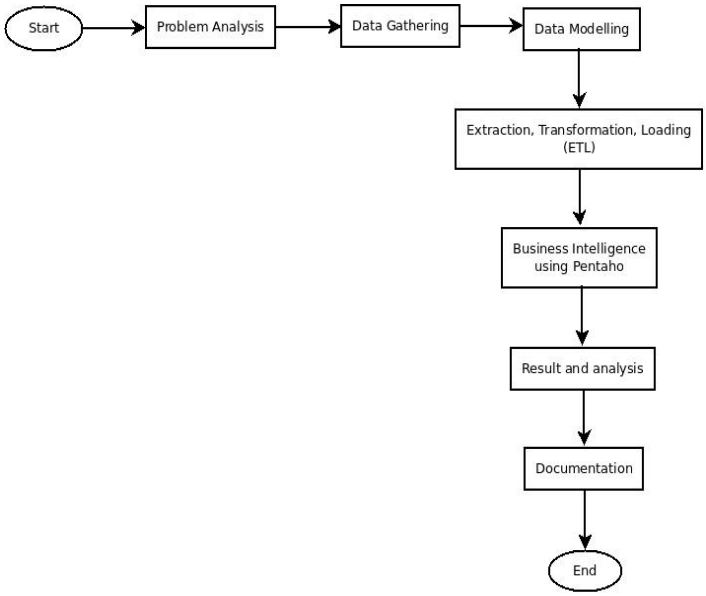

Figure 1. The flowchart of research

2.2. Data Warehouse

Data Warehouse is a structured database that contains a set of subject-oriented, integrated, time-dimensional, and non-variable data, which can be used to assist decision-making processes, data analysis, and data storage from various applications and services, to then be organized using Relational Data Base Management System (RDBMS)[11]. Data Warehouse collects data from various sources, standardizes the format, then processes it for data analysis through data dimensions [12].

2.3. Business Intelligence

The rapid development of Data Warehouse has made several variants appear, one of which is Business Intelligence. Business Intelligence is a variant or derivative of Data Warehouse that is used to meet the needs of users in accessing information as well as effective data management mechanisms[13]. Business intelligence also defined as a set of methodologies, processes, and technologies to convert transactional data into information that meaningful and useful for organization and business, based on Data Warehouse[14]. The methods and methodologies contained in the Data Warehouse can also be used in Business Intelligence: On-Line Transactional Processing (OLTP), On-Line Analytical Processing (OLAP), multi-dimensional data, Kimball Nine-Step Methodology, and Extraction, Transformation, Loading (ETL).

2.4. On-Line Transactional Processing (OLTP)

On-Line Transactional Processing (OLTP) is a technique and method in Data Warehouse and Business Intelligence that collects and processes transactional data originating from transactional data sources (applications, services, information systems, spreadsheets) connected within a computer network[15]. The Data Warehouse collects transactional historical data from various sources, where this data cannot be fully used for analysis needs without going through a process in OLTP before to OLAP.

2.5. On-Line Analytical Processing (OLAP)

On-Line Analytical Processing (OLAP) is a data processing technique and method in the Data Warehouse that uses transactional data in OLTP to become analytical data, which can be visualized and represented to support data analysis processes, where data is stored in the form of multi-dimensional data[16]. In terms of data analysis, OLAP has an important role in Data Warehouse and Business Intelligence to facilitate the process of data analysis because data is displayed in the form of several different data dimensions.

2.6. Multi-Dimensional Data

Multi-dimensional data is data in OLAP where data in OLAP is stored in the form of a number of data dimensions with three attributes, namely: 1.) Dimensions as attributes being reviewed, 2.) Measurers as measurable quantities that refer to the intersection between dimensions reviewed, 3.) Calculation of the measurement results as the value of the measurement[17]. With the presentation of data in the form of multi-dimensional data (minimum 3 dimensions) it will make it easier for the OLAP method to carry out data analysis following the objectives of the Data Warehouse and Business Intelligence[18]. For multidimensional data, it is generally visualized in the form of cubes (six sides), tables, or X, Y, Z axis graphs. In its development, multidimensional data is also applied to graph databases[19].

2.7. Kimball Nine-Steps Methodology

Kimball Nine-Steps Methodology is a methodology on Data Warehouse and Business Intelligence that consists of nine steps to build and develop Data Warehouse and Business Intelligence-based systems as well as applications and other services based on both[20]. The nine steps to the Kimball Nine-Steps Methodology include: 1.)Choose a process, 2.)Choose the grains, 3.)Identify and adjust dimensions, 4.)Choose facts, 5.)Store pre-computations in the fact table, 6.)Rounding off the dimension table, 7.)Choose the dimension duration, 8.)Keep track of slowly changing dimensions, 9.)Deciding query priority and query mode[21]. [22].

At the phase of choose the process, six business processes occur in product supervision. The six business processes are: 1.)Control order, 2.)Planning activities, 3.)Supervision, 4.)Supervision process, 5.)Oversight Correction, 6.)Follow-up supervision. Details of each business process can be seen in Table 1.

Table 1. Detail of Each Business Process

Business Process	Description	Role
Supervision Order	Order of supervision of goods in the market	The Bali Provincial Office of Industry and Trade
Planning Activities	Planning to supervision of goods at market	The Bali Provincial Office of Industry and Trade
Supervision	The act of supervision of goods at the market, divided into type of goods	The Bali Provincial Office of Industry and Trade
Supervision Processes	The act of supervision of goods at the market (data saved into spreadsheets, apps, and web, which can be as the data source for Business Intelligence and Data Warehouse system)	The Bali Provincial Office of Industry and Trade
Supervision Corrections	The correction of errors during the process to make it clear	The Bali Provincial Office of Industry and Trade
Follow-Up Supervision	The follow-up after the process of supervision	The Bali Provincial Office of Industry and Trade

The phase of choosing the grain or granularity determination is carried out after knowing what business processes are happening. The results of this process will be made as a table of facts. The grain that was produced including: 1.)Supervision Date, 2.)Regency, 3.)Company Name, 4.)Company Address, 5.)Supervised Products, 6.)Findings and Follow-Up.

At the phase of identifying and confirming dimensions, the identification of dimensions is linked to the fact table. From the identification results, it can be determined that the form of three-dimensional data is illustrated on the XYZ axis, namely: 1.) Product Dimensions on the X axis, 2.)

Time Dimensions on the Y axis, 3.) Feasibility Dimensions on the Z-axis. Multidimensional data using the XYZ axis is shown in Figure 2.

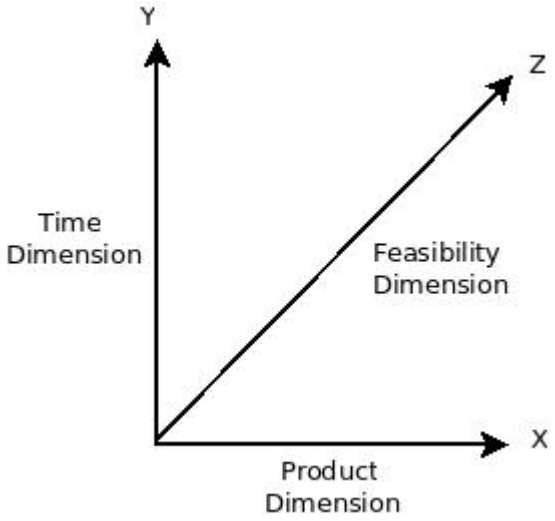

Figure 2. Multidimensional Data Using the XYZ Axis

In the phase Choosing The Fact, the selection of facts is done after determining the dimensions to be used. Data in fact tables will be displayed in the form of reports and diagrams. The fact table used is monitoring data with attributes including id_time, id_product, id_feasibility, and status.

At storing pre-calculations in the fact table, the calculation of the fact table is carried out and the results of the pre-calculation are stored. At choosing the duration of the dimension, the duration of data collected in the Data Warehouse-based Business Intelligence system is owned by The Bali Provincial Office of Industry and Trade, which in this case is the data for the last three years only. Data came from several sources, ie: applications, spreadsheets, web, and information systems. At tracking slowly changing dimensions, a calculation is made for the slowly changing dimensions, which can be traced. In this case, there are no such things in The Bali Provincial Office of Industry and Trade data.

The last, at deciding the query priorities and the query modes, physical design is done to produce a Business Intelligence system with the concept of a Data Warehouse that is ready to be implemented in The Bali Provincial Office of Industry and Trade using the Pentaho Business Intelligence (BI) tool. At this phase, a query or reporting provision is made to display data according to the needs of The Bali Provincial Office of Industry and Trade. In this case, it is for the supervision of product feasibility.

2.8. Extraction, Transformation, Loading (ETL)

Extraction, Transformation, Loading (ETL) is a core process in Data Warehouse and Business Intelligence which contains a set of processes for retrieving and processing transactional or operational data from one or several data sources into a new source, extracting data from selected sources to convert into a format according to business rules, then load it into the target data structure[23]. ETL helps process transactional data on OLTP into analytical data on OLAP[24]. ETL has an important role in Data warehouses and Business Intelligence to facilitate data analysis processes related to data-based decision-making[25].

In this research, after analyzing the dimension tables and determining the facts that will be used, a database is created for the data warehouse using MariaDB DBMS in the form of Physical Data Model (PDM). After create a database, data will undergo an Extraction, Transformation,

Loading (ETL) process using the Pentaho Business Intelligence (BI) Tool. The ETL scheme shown at Figure 3.

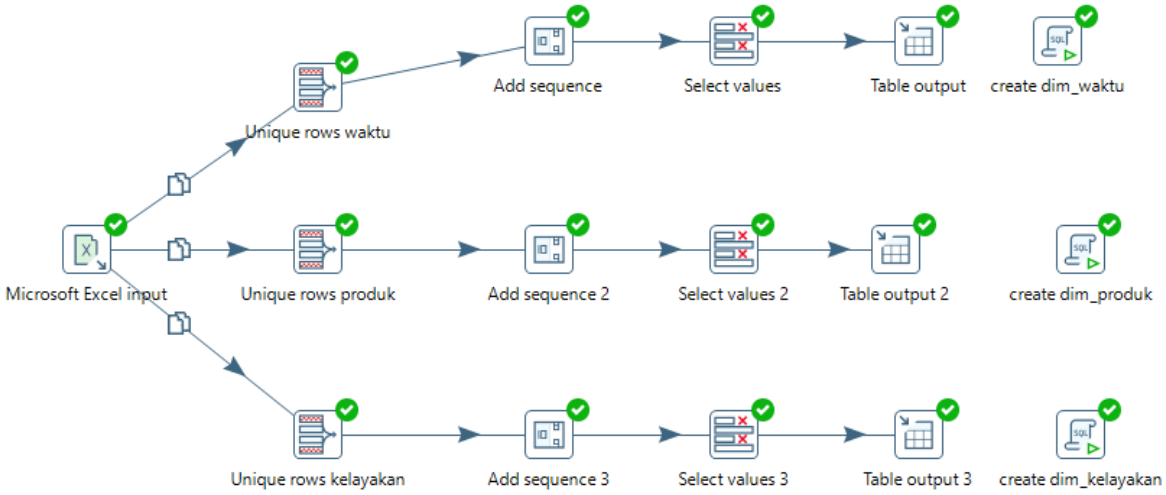

Figure 3. ETL Scheme Using Pentaho BI Tool

In ETL, Pentaho BI is connected to the database, then the data that comes from the data source is put together in the .xls (spreadsheet) file format. After that, then a Unique Row Input by selecting the fields to be used in the time table, Uniques Row Time, Products, and Eligibility. Then proceed with Add Sequence by selecting the name field as Primary Key. The Add Sequence process shown at Figure 4.

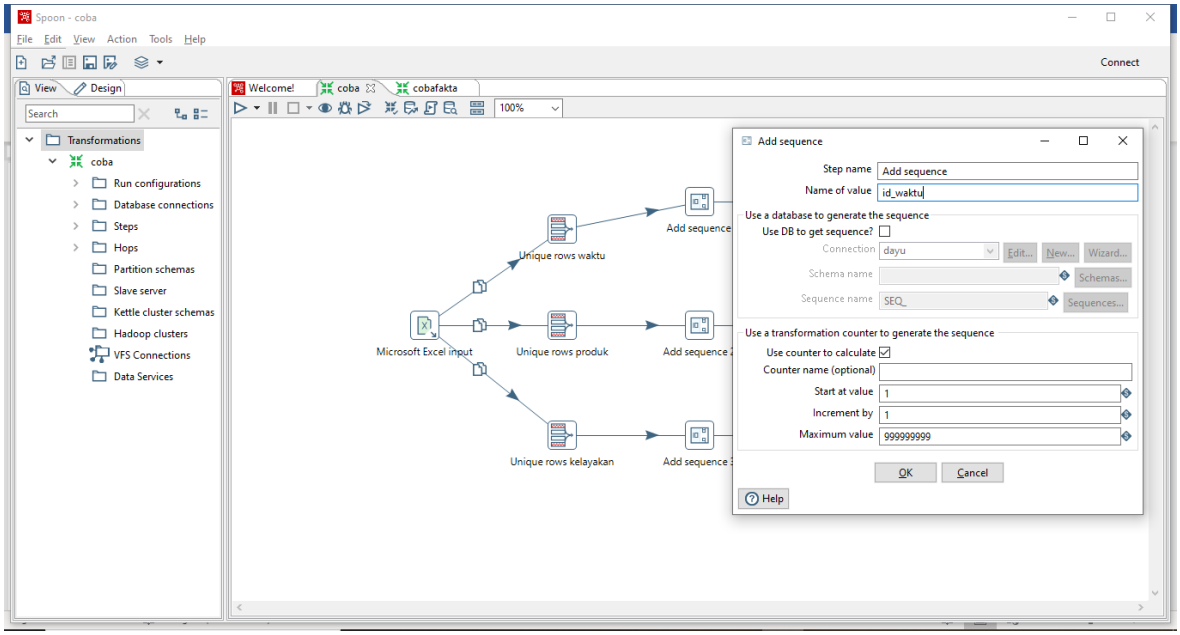

Figure 4. Add Sequence

After the Add Sequence process, the phase is continue with Select Values process, by adding the field to be used. The process ending with presenting the Output Table. The Select Values process shown at Figure 5.

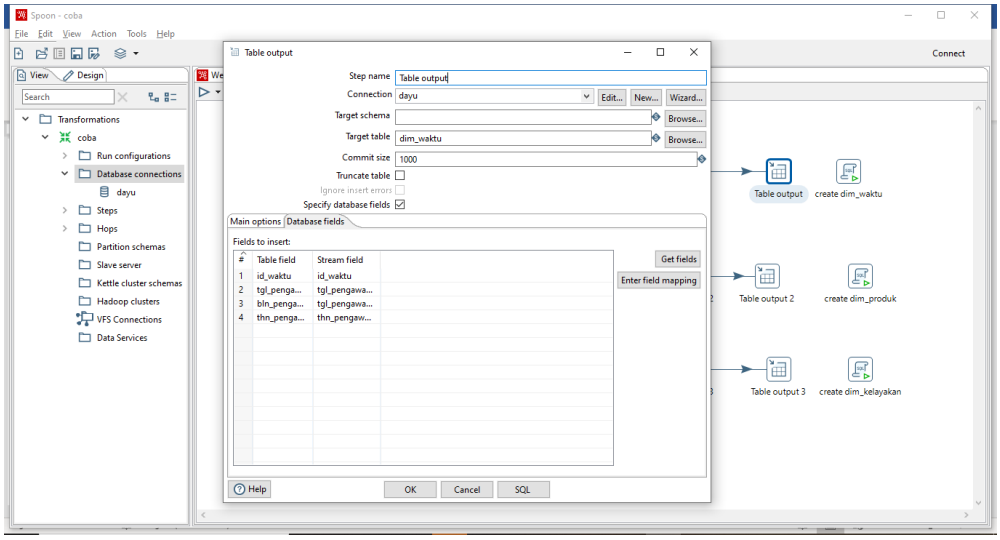

Figure 5. Select Values

Time Dimension (dimensi waktu or dim_waktu) table show the information about the data when success to insert into Time Dimension. Time Dimension consist of fields: id_waktu, tgl_pengawasan, and bln_pengawasan. Time Dimension table is shown at Figure 6.

```
MariaDB [db_pengawasan]> SELECT *FROM dim_waktu;
+----------+----------------+----------------+----------------+
| id_waktu | tgl_pengawasan | bln_pengawasan | thn_pengawasan |
+----------+----------------+----------------+----------------+
| 001      |              2 |              2 |           2016 |
| 004      |              3 |              3 |           2016 |
| 007      |             15 |             15 |           2016 |
| 010      |             16 |             16 |           2016 |
| 013      |             17 |             17 |           2016 |
| 016      |             18 |             18 |           2016 |
| 019      |             23 |             23 |           2016 |
| 022      |             24 |             24 |           2016 |
| 025      |             25 |             25 |           2016 |
| 028      |             17 |             17 |           2016 |
| 034      |             21 |             21 |           2016 |
| 037      |             22 |             22 |           2016 |
| 040      |             23 |             23 |           2016 |
| 043      |             24 |             24 |           2016 |
| 046      |             28 |             28 |           2016 |
| 049      |             29 |             29 |           2016 |
| 052      |             30 |             30 |           2016 |
| 055      |              4 |              4 |           2016 |
| 058      |             12 |             12 |           2016 |
| 061      |             18 |             18 |           2016 |
| 064      |             19 |             19 |           2016 |
| 067      |             20 |             20 |           2016 |
| 070      |             21 |             21 |           2016 |
| 073      |             25 |             25 |           2016 |
| 076      |             26 |             26 |           2016 |
| 079      |             27 |             27 |           2016 |
| 082      |             10 |             10 |           2016 |
| 085      |             16 |             16 |           2016 |
| 088      |             17 |             17 |           2016 |
| 091      |             18 |             18 |           2016 |
| 094      |             19 |             19 |           2016 |
| 097      |             23 |             23 |           2016 |
| 100      |             24 |             24 |           2016 |
| 103      |             25 |             25 |           2016 |
| 106      |             26 |             26 |           2016 |
| 109      |              6 |              6 |           2016 |
```

Figure 6. Time Dimension

Product Dimension (dimensi produk or dim_produk) table show the information about the data when success to insert into Product Dimension. Product Dimension consist of fields: id_produk, merk_produk, jenis_produk, and produk_diawasi. Product Dimension table is shown in Figure 7.

```
MariaDB [db_pengawasan]> SELECT *FROM dim_prdouk;
+-----------+------------------------+-------------+--------------------------+
| id_produk | merk_produk            | jenis_produk | produk_diawasi          |
+-----------+------------------------+-------------+--------------------------+
| p01       | Shimizu                | Elektronika | Pompa Air Listrik        |
| p02       | Superindo              | SNI         | Kabel Listrik            |
| p03       | Cakra Kembar           | SNI         | Tepung Terigu            |
| p04       | Shimizu                | Elektronika | Pompa Air Listrik        |
| p05       | Seiricite              | SNI         | Closet Duduk             |
| p06       | Makaci                 | SNI         | Helm                     |
| p07       | Denpoo                 | Elektronika | Kipas Angin Kotak        |
| p08       | Neursl Plano           | SNI         | LHE                      |
| p09       | ARC Lencana Merah      | SNI         | Helm                     |
| p10       | Hacida                 | Elektronika | Kipas Angin Berdiri      |
| p100      | Extrana                | SNI         | Kabel Listrik            |
| p101      | Polytron               | Elektronika | Mesin Cuci               |
| p102      | Lencana Merah          | SNI         | Tepung Terigu            |
| p103      | Fokus                  | SNI         | Kabel Listrik            |
| p104      | Kirin                  | Elektronika | Magic Com                |
| p105      | Vitara                 | Elektronika | Pelumat                  |
| p106      | Hansonic               | SNI         | Kabel Listrik            |
| p107      | Sangsang               | SNI         | AMDK                     |
| p108      | Tiki                   | SNI         | LHE                      |
| p109      | Multi Pro              | Elektronika | Pompa air listrik        |
| p11       | Kirin                  | Elektronika | Setrika Listrik          |
| p110      | INCOE                  | SNI         | Accu                     |
| p111      | Meet                   | SNI         | LHE                      |
| p112      | Zito                   | SNI         | Kabel listrik            |
| p113      | DAB                    | Elektronika | Pompa air listrik        |
| p114      | MCRI                   | SNI         | LHE                      |
| p115      |  Ceystal               | Elektronika | Penanak Nasi             |
| p116      | Tonasa                 | SNI         | Semen                    |
| p117      | Sintani                | SNI         | Kabel Listrik            |
| p118      | Campus                 | SNI         | Kabel Listrik            |
| p119      | Campus                 | SNI         | LHE                      |
| p12       | Pancaran               | SNI         | LHE                      |
| p120      | Cheers                 | SNI         | Air Minum Dalam Kemasan  |
| p121      | Supreme Cable          | SNI         | Kabel Listrik            |
| p122      | Merah Putih            | SNI         | Semen                    |
```

Figure 7. Product Dimension

Feasibility Dimension (dimensi kelayakan or dim_kelayakan) table show the information about the data when success to insert into Feasibility Dimension. Feasibility Dimension consist of fields: id_kelayakan, hasil_temuan, and tindak_lanjut. Feasibility Dimension table is shown in Figure 8.

```
MariaDB [db_pengawasan]> SELECT *FROM dim_kelayakan;
+--------------+--------------------------------------------------------------------+----------------------------------------
---------------------------------------------------------------------------------------------------------------------------+
| id_kelayakan | hasil_temuan                                                       | tindak_lanjut
                                                                                                                           |
+--------------+--------------------------------------------------------------------+----------------------------------------
---------------------------------------------------------------------------------------------------------------------------+
| k01          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k02          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k03          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k04          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k05          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k06          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k07          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k08          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
| k09          | Peredaran produk ini tidak mencantumkan nomor pendaftaran dan nama produsen  | Memberikan pembinaan secara langsung kepada pe
rlaku, dan produk dispenser yang tidak tercantum nomer pendaftaran dan nama produsen agar tidak dijual kepada konsumen      |
| k10          | Peredaran produk sudah sesuai dengan ketentuan yang berlaku        | Pelaku usaha tetap diberi pembinaan agar mema
g lengkap sesuai dengan ketentuan yang berlaku                                                                             |
```

Figure 8. Feasibility Dimension

The feasibility dimension can also assist the Bali Province Industry and Trade Office in the decision-making process to assess the feasibility of goods on the market, based on the parameters of the eligibility of goods, findings, and follow-up.

3. RESULTS AND DISCUSSION

The design and implementation of Business Intelligence with the Data Warehouse concept using the Kimball Nine-Step Methodology, greatly assists the Bali Industry and Trade Service in making decisions regarding the process of controlling goods according to their duties. The nine steps in the Kimball Nine Step Methodology are very helpful in designing and implementing Business Intelligence systems starting from process selection, identification and selection of data dimensions, to data analysis to assist decision making. Methods in the Data Warehouse in the form of multi-dimensional data, OLTP to OLAP, and Extraction, Transformation, Loading (ETL), are adopted in Business Intelligence to standardize data and facilitate data analysis.

In addition, data from the supervision of goods circulating in the market which were previously only based on manuals, spreadsheets, applications, and information systems, can now be managed by the Bali Industry and Trade Agency based on the Business Intelligence system using the Pentaho Business Intelligence open source tool, to help the organization to achieve the desired goals.

4. CONCLUSION

Based on the tests that have been carried out, it can be concluded that the application of the Kimball Nine-Steps Methodology to the Business Intelligence system that was built, is carried out sequentially from process selection, identification of data dimensions, to queries and data analysis to produce information that supports the decision-making process. In the future, this research can be continued by using other methods that can be adopted in Business Intelligence.

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REFERENCES

[1] Badan Pemeriksa Keuangan (BPK) Republik Indonesia. Undang-Undang nomor 8 Tahun 1999 tentang Perlindungan Konsumen. JDIH BPK RI Database Peraturan. 2000.
Retrieved: https://peraturan.bpk.go.id/Home/Details/45288/uu-no-8-tahun-1999

[2] Kementerian Perdagangan Republik Indonesia. Homepage.
Retrieved: https://www.kemendag.go.id/id

[3] N. Marsela, and B. Hermanto, "Implementasi Business Intelligence untuk Penilaian Mutu Pelayanan di Rumah Sakit Umum Daerah Tulang Bawang Barat," Jurnal Pepadun, Vol.3, No.2, 2022. pp.179-193.

[4] A.W. Iswara, et al., "Implementation of Business Intelligence for Quality Support of RSUD Ir. Soekarno Sukoharjo with Data Warehouse," ITSMART: Jurnal Ilmiah Teknologi dan Informasi, Vol.9, No.1, 2020.

[5] Syarli, et al., "Perancangan Business Intelligence System pada Gudang Farmasi Dinas Kesehatan Kabupaten Mamasa," Jurnal Keteknikan dan Sains (JUTEKS) LPPM UNHAS, Vol.1, No.1, 2018.

[6] G.M.M. Castro, et al., "Business Intelligence Tools for a Digital Services Company in Peru," International Journal of Business Intelligence Research (IJBIR), Vol.14, No.1, 2022.

[7] A. Suhendar, and T. Hikmatunnisa, "Penerapan Business Intelligence pada Peluang Jenis Usaha Baru Usaha Mikro Kecil Menengah dengan Menggunakan Teknologi On Line Analytical Processing," Jurnal Sistem Informasi (JSIL), Vol.9, No.2, 2022.

[8] R. Akbar, e al., "Implementasi Business Intelligence untuk Mendapatkan Pola Penerbangan Penumpang Pesawat dari atau ke Bandara Internasional Minangkabau," Jurnal Edukasi dan Penelitian Informatika (JEPIN), Vol.4, No.1, 2018.

[9] A. Zikri, et al., "Implementasi Business Intelligence untuk Menganalisis Data Persalinan Anak di Klinik Ani Padang dengan Menggunakan Aplikasi Tableau Public," Jurnal Online Informatika (JOIN), Vol.2, No.1, 2017.

[10] R. Akbar, et al., "Implementasi Business Intelligence untuk Menentukan Mahasiswa Penerima Beasiswa," Jurnal Ilmiah Rekayasa dan Manajemen Sistem Informasi, Vol.3, No.1, 2017.
[11] Pratama, I.P.A.E., "Handbook Data Warehouse," Penerbit Informatika. 2018.
[12] M. Furqon, and M.F. Nugraha, "Perancangan Data Warehouse Sistem Pendaftaran Mahasiswa Menggunakan Online Analytical Procesing (OLAP) di Universitas Ma'soem," INTERNAL (Information System Journal), Vol.4, No.1, 2021. pp.35-40.
[13] Syarli, et al., "Perancangan Business Intelligence System pada Gudang Farmasi Dinas Kesehatan Kabupaten Mamasa," Jurnal Keteknikan dan Sains (JUTEKS), Vol.1, No.1, 2018.
[14] W.S. Fana, et al, "Data Warehouse Design with ETL Method (Extract, Transform, and Load) for Company Information Centre," International Journal of Artificial Intelligence Research (IJAIR), Vol.5, No.2, 2021. pp.132-137.
[15] Q. Umam, et al., "Analisis Dan Perancangan Data Warehouse Menggunakan Pendekatan Mixed-Driven (Studi Pada Dinas Komunikasi dan Informatika Kabupaten Sidoarjo)," Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, Vol.3, No.2, 2019.
[16] J. Purwanto, and Renny, "Perancangan Data Warehouse Rumah Sakit Berbasis On-Line Analytical Processing (OLAP)," Jurnal Teknologi Informasi dan Ilmu Komputer (JTIIK), Vol.8, No.5, 2021. pp.1077-1088.
[17] M.F. Zulkarnaina, et al, "Perancangan dan Implementasi Data Warehouse Penjualan (Studi Kasus: Northwind Sample Database)," Jurnal Elektronik Ilmu Komputer Udayana, Vol.10, No.1. 2021.
[18] A. Muhammad, et al., "Perancangan Business Intelligence dengan Konsep Data Warehouse OLAP Untuk Mengetahui Kemampuan Mahasiswa pada Jurusan Teknik Informatika Mercu Buana Jakarta," Jurnal Ilmu Teknik dan Komputer, Vol.4, No.2, 2020.
[19] S. Esser, and D. Fahland, "Multi-Dimensional Event Data in Graph Databases," Journal on Data Semantics, Vol.10, 2021. pp.109–141.
[20] E.K. Suni, "Analisis dan Perancangan Data Warehouse Untuk Mendukung Keputusan Redaksi Televisi Menggunakan Metode Nine-Step Kimball," Jurnal Teknik Informatika, Vol.11, No.2, 2018.
[21] G. Wijaya, "Perancangan Data Warehouse Nilai Mahasiswa Dengan Kimball Nine-Step Methodology," Jurnal Informatika, Vol.4, No.1, 2017.
[22] M. Akbar, and Y. Rahmanto, "Desain Data Warehouse Penjualan Menggunakan Nine Step Methodology Untuk Business Intellgence pada PT Bangun Mitra Makmur," Jurnal Informatika dan Rekayasa Perangkat Lunak, Vol.1, No.2, 2020.
[23] I.P.W. Prasetia, and I.N.H. Kurniawan, "Implementasi ETL (Extract, Transform, Load) pada Data Warehouse Penjualan Menggunakan Tools Pentaho," TIERS Information Technology Journal, Vol.2, No.1, 2021. pp.39-47.
[24] A.R. Iskandar, et al., "Extract, Transform, Load sebagai upaya Pembangunan Data Warehouse," Journal of Informatics and Communication Technology (JICT), Vol.1, No.1, 2019.
[25] N.W.S. Saraswati, and N.M.L. Martarini, "Extract Transform Loading Data Absensi STMIK STIKOM Indonesia Menggunakan Pentaho," Jurnal MATRIK, Vol.19, No.2, 2020. pp.273-281.