Data Warehouse Design for Electronic Manufacturing Company

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Abstract– Recently, managing data in electronic manufacturing company has become a challenge.This paper presents the design of a data warehouse based on user needs forelectronic manufacturing company. The data warehouse is designed using Kimball's Method. The purpose of the proposed design is to help decision makers in performing data processing and data analysis over the data stored in the warehouse. The data warehouse design based on user needs which provides a data source to support corporate leaders for enhance the decisionmaking process. Database Management System used is Oracle Database XE. This StudyincludesIntegrity check process and User Acceptance Test.This study reflects that user find the data warehouse fulfill the user needs.

Keywords– *Data Warehouse, Kimball method, Dimensional Model, Integrity Check.*

I. INTRODUCTION

Data warehouse is a subject-oriented, integrated, time-variant, and nonvolatile collection of data in support of management's decision making process [1]. Currently thedata warehouse systemsupports not onlyreports butalsoprovidesa better analysis,such asmultidimensional analysisandpredictionsthat used for decision making process.

A data warehouse is a collection of data from several major sources, such as database transactions and data distributions, thereforeusercan easily analyze the data and create reports [2].Managing data within a manufacturing company to be challengeas a result of differences in user needs, such as presents the total production, total payments or horizontally customers. Manage the data in electronic manufacturing company is a challenge of the different users needs.

The idea ofa data warehouseis based onOnline Analytical Processing(OLAP), which describes a technology thatusesmultidimensionaldata providequick access to get informationfor analysisand creating reports.

This paper proposes thedata warehouse designfor Electronic Manufacturing Company based on user needs which provides a data source to help corporate leaders for enhance decision making process. To fulfill users needs, the data warehouse design used the Spiral modeland Kimball method. This paper is divided into five sections. Section Ipresents introduction, section II presents related work, section III presentsproposed method, section IV presentsdata warehouse design, section V presents result and section VI presents conclusion.

II. RELATED WORK

This research was conducted through a few references as support in research data warehouse design electronic manufacturing company. Several references were made in support of this research are:

Research conducted by Alpa R Patel and Jayesh M Patel, 2012 examines the data warehouse model using model Entity-Relationship and data models dimensional. This study describes comparison of two data model. The conclusion is the Entity-Relationship in the design of data warehouse specifies the dependency relationship between the data without fact tables. Dimensional data model is preferable to design a data warehouse for company. The dimensional model has good queries performance to support OLAP functions[3].

Oketunji and Omodara, 2011, conducted to support the management of retail companies in make better decisions using historical data in available at the organization. Business users (decision makers) do not have the ability to access data easily when needed. In an effort to address these shortcomings, several departments within retail companies find their own resources using available data and hire a consultant to solve the data individually of their short-term needs. The data handled by the organization's operational needs of online transaction processing (OLTP) systems are essential for the daily running of the business. However, they are not very suitable to sustain demand for decision support or questions business managers typically need to address. The question involves analysis including aggregation, search and slicing / dicing of data, which is best supported by analytical processing (OLAP) systems online. Data warehouse support OLAP applications to store and maintain data in a multidimensional format. Data is extracted in a warehouse OLAP and OLTP taken from different sources of data (including DB2, Oracle, SQL Server and flat files) using the Extract, Transfer and Load (ETL) tools.Business activity has been operational data store long enough, and they continue to collect large amounts of data at a great

rate as the operational database becomes more valuable, helping to grow the rate at which businesses succeed. This paper shown that the data warehouse collect, consolidate, organize, and summarize this structured data so that this data can be used to inform business decisions [4].

Güzin, 2007, provide decision support system that has a query that is taken from the existing student information system and can produce reports as output to assist in decision making in the University AdministrationAtilim master programs. The method used by Güzin is the spiral model life cycle and Kimball. Kimball method uses a Dimensional Modelcan be used against multiple fact tables so can get varies on user needs and also the results of research Güzin Turkmen IALA retrieval history data quickly and save time [5].

Mohammed, 2014, used a structured database for a trading company that has many branches. The author provides a method of data warehouse that can be implemented by companies with high accuracy, this study applies two schemes namely star schema and snowflake schema with the concept of a multidimensional database. Where the author compares the two schemes and conclude star schema has a central fact (the fact table) that can be changed while the center (table fact) on a snowflake schema cannot be changed [6].

Leonard, 2011, involving technical description of data warehouse, design, needs, and challenges regarding the data cleansing and conversion of existing data, as well as other challenges associated with transactional database. This study also includes a discussion of database requirements and the technology used to create and refresh the data warehouse. This study discusses how data from other databases and data warehouse to be integrated. In addition, there is discussion of specific data marts in the data warehouse to meet special needs. The study also covers the topic of how the system architecture of data from other database and data warehouse from various departments can integrate. As a prototype developed Enterprise Data Warehouse database shows how different pair of experienced Extract, Transform and Load (ETL) process and loaded into the set is actually a star schema and then make reporting easier [7].

III. PROPOSED METHOD

According toSauter(2010), the qualityofa decisiondependsonthe adequacy ofexisting information, qualityinformation, and the amount of choiceandsuitabilityofmodeling. The good decisionis obtaininformation that relevantand targetedbyseveralalternative optionswhichhas thepurposeamong others: Completingthe decision-making, facilitateproblem-solving, provideassistancetodecisionnonstructuralandmanaging knowledgethatexist in the company [8].

To support the decision-making style a data warehouse can accommodate the use of data and decision-making. Connolly and Begg (2015)stated data warehouse is integrated view of corporate. Disparate data is drawn from the operational data sources and a range of end-user access tools capable of supporting simple to highly complex queries to support decision making [1].

System Development Life Cycle is used in this study is Spiral Model which consists ofrequirement gathering, requirement analysis, requirement modelling, designand evaluation.

The data warehouse design with four step of Kimball's Dimensional Lifecyclewhich be capable of supporting the information requirements of particular group of users. According to Kimball there are four steps process:Select Business Process, Declare Grain, Choose Dimensionsand Identify Fact [9].

Integrity Constraint is a concept that aims to prevent the entry of invalid data into the base table databasewhich can define boundaries to reinforce the business rules to associate the information on the database [1]. According to Connolly and Begg, Integrity Constraint consists of NULL, Entity Integrity,Referential Integrity and General Constraint.

IV. DATA WAREHOUSEDESIGN

A. Kimball's Method

The fourth section designed data warehouse used a four steps process of Kimball's Method, with details of the process as follows:

First step is select business processes. Ascan be seen in Fig. 1, business processes start from the procurement staff made an order to purchase material to the supplier. After ordering, supplier will send material to the company that will receive by the warehouse. In the warehouse the material checked by staff. If the material defects, it will be refund to supplier in return material process, while materials passed from checked will be sent for assembly into products. After the production the goods delivered to warehouse before delivered to customers. If any goods are defective, it will return in return goods process. Payment for materials and goods by finance company.

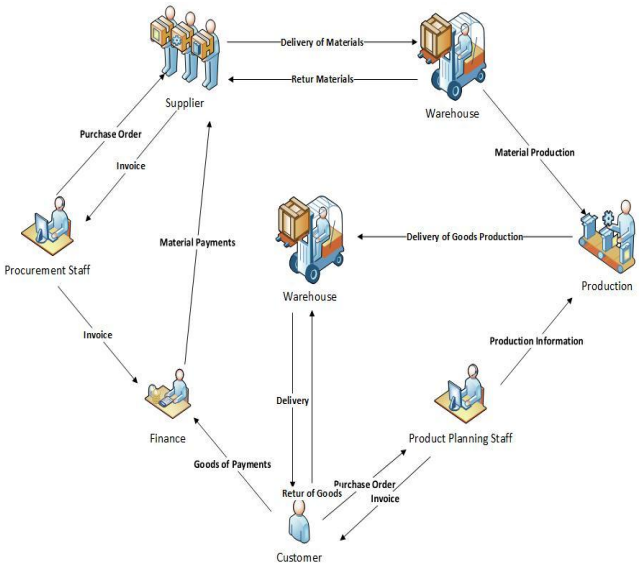

Fig 1:Business Process OfElectronicsManufacturing Company

The user needs related to the process that has been described previouslydisplayed in the model Entity Relationship in Fig. 2. Where dark entities representing the fact of the electronics manufacturing company.

Second step is declare grain. The grain in an attribute that fill in the fact tables. Identifies the grain for this study, namely:total material, sub total material, total return material, total pay material, total production, total material production, total goods, sub total goods, total return goods and total pay goods.

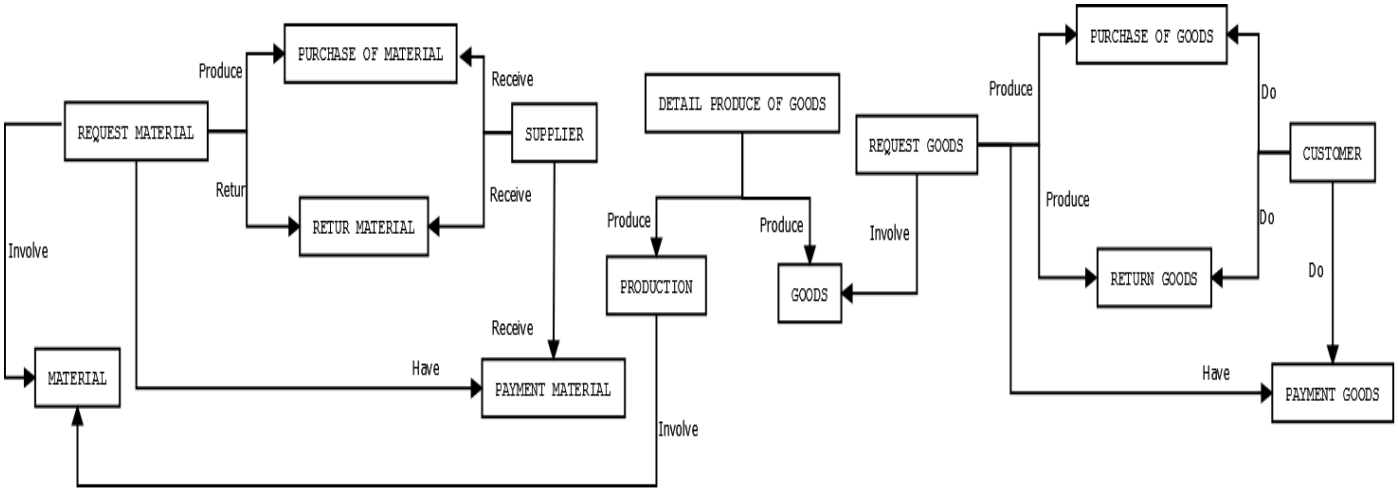

Fig 2 : Business Process Model Of Electronics Manufacturing Company

The third step is choose dimensions. Dimensions set context is needed later in the fact table. The dimensions identified namely:material, request material, supplier, goods, request goods, customer and production.

The last step isidentify facts. Grain from the fact table determine the facts that can be used in the dimensional model. The list of the fact tables arepurchase material table, returnsmaterial table, paymentmaterial table, production goods table, material production table, purchase goods table, returns itemstable and payment items table.

B. Entity Relationship Model

Entity-Relationship model design for data warehouse manufacturing company can be seen in Fig. 3. The design of model Entity-Relationship consists of 7 entities that are interconnected.

Entity Relationshipmodel design in figure 3 consists of 7 entities: request material entity, material returns entity, payments material entity, request goods entity, returns goods entity, payments goods entity and production entity.

C. Dimensional Model

Dimensional models in the design of Electronic Manufacturing Data Warehouse use Star Schema based Kimball Dimensional Lifecycle. Thestar schema can be seen in Fig. 4.

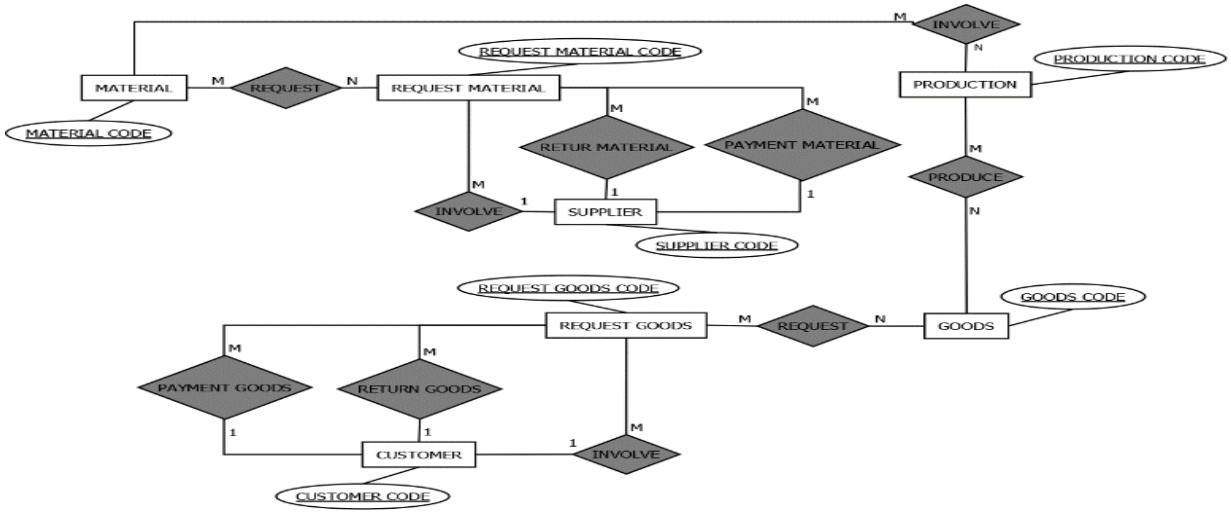

Fig 3: Entity-Relationship Data Warehouse Design Electronics Manufacturing Company

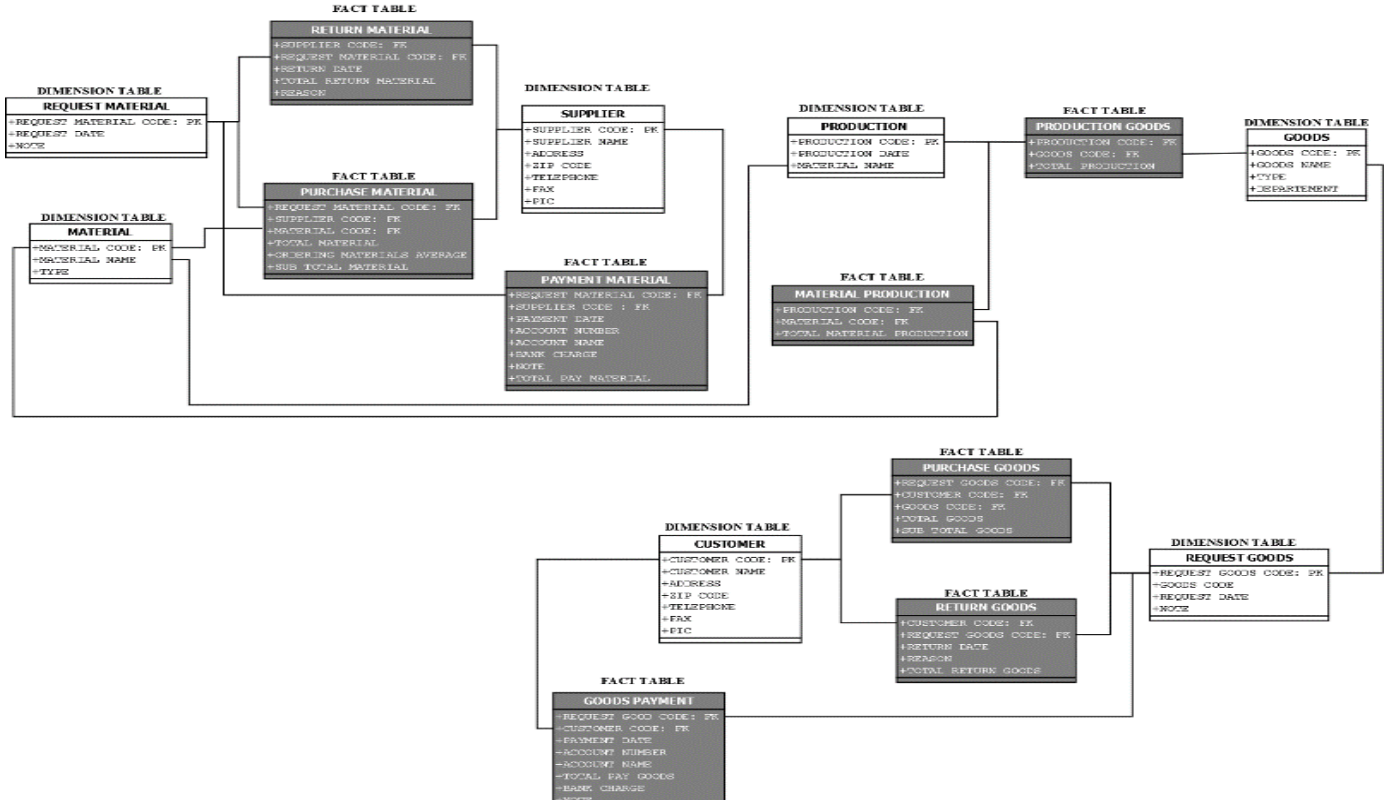

Fig 4 : Dimensional Model Data Warehouse Design Manufacturing Company

V. RESULT

A. Prototype Data Warehouse

The data warehouse design is implemented using Oracle Database XE. The design based on the fact tables and dimension tables. This prototype has been equipped with Integrity Constraint on each table. For Integrity Constrain affixed to the table's data warehouse.

Prototype Data Warehouse consists of 15 tables : material table, request material table, purchase material table, return material table, material payment table, supplier table, goods table, purchase goods table, customer tables, request goods table, return goods table, payment goods table, production table, production goods table and material production table.

B. Report

The design report serves as the reporting data that has been stored and processed in the data warehouse. In designing data warehouse is produced 11 reports, namely:purchase material report, returns material report, material payment report, purchase goods report, return goods reports, payment goodsreport, average purchase materialreport, sub total purchase material report, sub total sales of goodsreports, goods production report and material production report.

Designing reports displayed on Excel to facilitate programmers in creating a report later. For example in the design data report purchases material made with the following query:

```
select "BOOKMT"."CD_MTREQ" as "REQUEST MATERIAL CODE",
       "BOOKMT"."CD_SUPPLIER" as "SUPPLIER CODE",
       "SUPPLIER"."NM_SUPPLIER" as "SUPPLIER",
       "REQMT"."REQDATE" as "REQUEST DATE",
       "MATERIAL"."NM_MATERIAL" as "MATERIAL",
       "BOOKMT"."TOTAL_ITEM" as "TOTAL MATERIAL",
       "BOOKMT"."AMOUNT_ITEM" as "TOTAL AMOUNT",
       "BOOKMT"."NOTE" as "NOTE"
 from  "SUPPLIER" "SUPPLIER",
       "BOOKMT" "BOOKMT",
       "REQMT" "REQMT",
       "MATERIAL" "MATERIAL"
 where "BOOKMT"."CD_MTREQ"="REQMT"."CD_MTREQ"
 and "BOOKMT"."CD_SUPPLIER"="SUPPLIER"."CD_SUPPLIER"
 and "REQMT"."CD_MATERIAL"="MATERIAL"."CD_MATERIAL"
order by BOOKMT.CD_MTREQ ASC
```

In this report, there are eight data displayed: Request Material Code, Supplier Code, Supplier Name, Request Date, Material Name, Material Total, Total Amount and Note. When observed, there is a blue color under the name of the column. The blue color is to indicate source of data, in order to facilitate the programmer put it on the actual report.The display example of a draft reportsas follows:

	A	B	C	D	E	F	G	H
1	[COMPANY NAME]							
2								
3				REPORT PURCHASE MATERIAL				
4								
5								
6	REQUEST MATERIAL CODE	SUPPLIER CODE	SUPPLIER	REQUEST DATE	MATERIAL	TOTAL MATERIAL	TOTAL AMOUNT	NOTE
7	[CD_MTREQ]	[CD_SUPPLIER]	[NM_SUPPLIER]	[REQDATE]	[NM_MATERIAL]	[TOTAL_ITEM]	[AMOUNT_ITEM]	[NOTE]
8								
9								
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21								
22							[EXICEOUTION TIME]	

Fig 5: Purchase Material Report

Another design report regarding to return material, the data created with the following query:

```
select "RETURNMT"."CD_MTREQ" as "REQUEST MATERIAL CODE",
       "SUPPLIER"."NM_SUPPLIER" as "SUPPLIER",
       "MATERIAL"."NM_MATERIAL" as "MATERIAL",
       "RETURNMT"."RETURN_DATE" as "RETURN DATE",
       "RETURNMT"."TOTAL_RETURN" as "TOTAL RETURN",
       "RETURNMT"."REASON" as "REASON"
 from  "REQMT" "REQMT",
       "SUPPLIER" "SUPPLIER",
       "RETURNMT" "RETURNMT",
       "MATERIAL" "MATERIAL"
 where "REQMT"."CD_MATERIAL"="MATERIAL"."CD_MATERIAL"
 and "RETURNMT"."CD_MTREQ"="REQMT"."CD_MTREQ"
 and "RETURNMT"."CD_SUPPLIER"="SUPPLIER"."CD_SUPPLIER"
order by RETURNMT.RETURN_DATE ASC
```

There are six data displayed: Request Material Code, Supplier Name, Material Name, Return Date, Total Return and Reason. The blue color under column name indicate source of data.

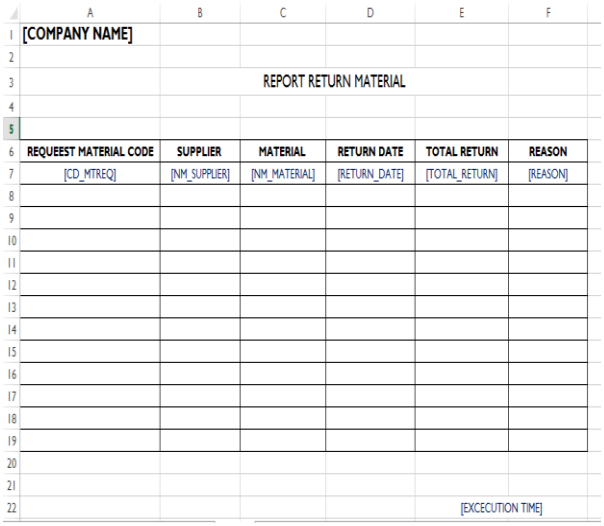

Fig 6 :Return material report

C. Integrity Check

This study applied an integrity checkprocess. The checking based on the Integrity constraint of the data warehouse through building prototypes. In this study there are eight processes involved, namely: material purchase, return material, material payment, purchase goods, return goods, payment goods, production goods and material production. Integrity Check processof the data warehouse can be seen in Table 1.

TABLE 1
INTEGRITY CHECK IN DATA WAREHOUSE MANUFACTURING COMPANY

Schema	Tables	Columns	Primary Keys	Foreign Keys	Not Nulls	Uniques	Check	Total Constraint
Material Production	3	9	8	8	7	-	-	35
Payment Goods	3	17	2	2	6	1	1	32
Payment Material	3	18	2	2	8	1	1	35
Production Goods	3	10	2	2	7	-	-	24
Purchase Goods	4	19	3	3	10	1	1	41
Purchase Material	4	19	3	3	10	1	1	41
Return Goods	3	15	2	2	5	1	1	29
Return Material	3	15	2	2	7	1	1	31
Total	26	122	24	24	60	6	6	268

Integrity Constraint checks carried out by trying to enter the data that is contrary to the Integrity Constraint applied to each process. Update the data in the data which has a relationship and finally perform deletion on data that have relationships. This check is merely checking the input, update and delete data manually through prototype data warehouse that has been made. Constraint checks carried out on the data warehouse manufacturing companies, namely: checking primary key, foreign key checks, checks not null, unique constraint checking and checking of the check constraint.

D. Evaluation Result

This study using User Acceptance Test to evaluate the performance of the database. The Database is evaluated by 15 users. Users fill out a questioner consisting of 10 statement that can be seen in Table 2.

TABLE 2
QUESTIONER STATEMENT

Q1	Data which is attached to the design of the Data Warehouse Electronics Manufacturing Company has full accordance with user needs.
Q2	Designing the Data Warehouse Electronics Manufacturing Company can demonstrate the amount of material and the amount of goods.
Q3	Designing the Data Warehouse Electronic Manufacturing company can show the number of returns of material and return of goods.
Q4	Designing the Data Warehouse Electronics Manufacturing Company can demonstrate the amount of material ordering and ordering goods.
Q5	Designing the Data Warehouse Electronics Manufacturing Company can demonstrate material payments and payment of goods.
Q6	Designing the Data Warehouse Electronics Manufacturing Company can demonstrate material payments and payment of goods.
Q7	Designing the Data Warehouse Electronics Manufacturing Company can indicate the amount of production of goods.
Q8	Testing duplicate data through Integrity Constraint on the customer and supplier are in accordance with the needs of users where there are no similar data.
Q9	Integrity Constraint function accordance with user needs.
Q10	Dimensions contained in the Data Warehouse design Electronics Manufacturing Company are in accordance with user needs such as Material, Item, Customer, Supplier, and Returns.

The result is performed by compute the percentages of number of users who choose strongly agree, agree, neutral, disagree and strongly disagree. The percentage of each assessment can be seen as follows:

$$\text{Result} = \frac{\text{Strongly Agree}}{\text{Total Strongly Agree} + \text{Total Agree} + \text{Total Neutral} + \text{Total Disagree} + \text{Total Strongly Disagree}} X$$

$$\text{Result} = \frac{\text{Agree}}{\text{Total Strongly Agree} + \text{Total Agree} + \text{Total Neutral} + \text{Total Disagree} + \text{Total Strongly Disagree}} X$$

$$\text{Result} = \frac{\text{Neutral}}{\text{Total Strongly Agree} + \text{Total Agree} + \text{Total Neutral} + \text{Total Disagree} + \text{Total Strongly Disagree}} X$$

$$\text{Result} = \frac{\text{Disagree}}{\text{Total Strongly Agree} + \text{Total Agree} + \text{Total Neutral} + \text{Total Disagree} + \text{Total Strongly Disagree}} X$$

$$\text{Result} = \frac{\text{Strongly Disagree}}{\text{Total Strongly Agree} + \text{Total Agree} + \text{Total Neutral} + \text{Total Disagree} + \text{Total Strongly Disagree}} X$$

Overall the result of the questioner can be seen in Table 3.

TABLE 3
QUESTIONER RESULT

Statement	SA	A	N	A	SD
Q1	3	7	5	0	0
Q2	2	8	5	0	0
Q3	1	12	2	0	0
Q4	1	9	5	0	0
Q5	3	11	1	0	0
Q6	2	12	1	0	0
Q7	3	10	2	0	0
Q8	9	3	3	0	0
Q9	8	4	3	0	0
Q10	3	7	5	0	0

Information :
SA : Strongly Agree
A : Agree
N : Neutral
D : Disagree
SD : Strongly Disagree

The statement shown in bar chart can be seen in Figure 7. Orange color indicates users strongly agree, yellow colorindicates users agree, green colorindicates a neutral, red colorindicates users not agree and brown color indicates the users strongly disagree.

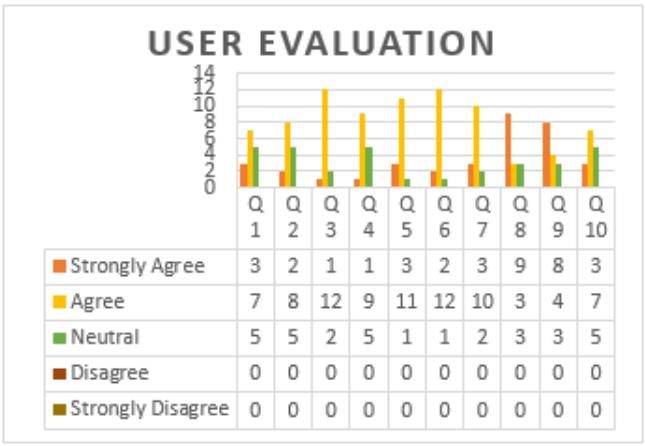

Fig 7:User Evaluation Result

This paper obtained 7 dimension tables and 8 fact tables and 11 draft reports that serves as a report of the data stored and processed in the data warehouse. This study was completed by getting the user evaluation.55,33% ofuser statedagree of the statement, 23,33% of user statedstrongly agree of the statement and 21,33% of user neutral. Therefore it can be said that user in this company are satisfied withthe data warehouse design because the database matched the user needs.

VI. CONCLUSIONS

The Data Warehousedesign for Electronic Manufacturing Company is presented in this paper.The Data warehouse is designed using spiral approachand Kimball method. The design is implemented using Oracle Database XE. This Study includes Integrity check process and User Acceptance Test. The performance result shows that the data warehouse is match the user needseventually helps them in discovering critical patterns and trends. However, there is still more research needed to improve the performance result.For the next research thedatabase design should be added by a wider scope of processes such as include a journal for each transaction. In addition, the future study should also add an ETL process.

REFERENCES

[1] Connolly, T, M., and Begg C. E, *Database Systems: A Practical Approach to Design, Implementation and Management*, 6th Edition, Pearson Education, 2015.
[2] IBM Corporation, Database Fundamental, IBM Canada, Canada,2010.
[3] Patel, Alpa R., Patel, Jayesh M, "Data Modeling Techniques for Data Warehouse", International Journal of Multidisciplinary Research, Vol. 2, Issue 2, February 2012.
[4] Oketunji, Temitope A., Omodara, Raufu O, "Design of Data Warehouse and Business Intelligence System: A Case Study of a Retail Industry", thesis, School of Computing Blekinge Institute of Technology, Sweden, 2011.
[5] Türkmen, Güzin, "Developing a Data Warehouse for a University Decision Support System". A Master's Thesis. Turkey, 2007.
[6] Mohammed, Khalid Ibrahim, "Data Warehouse Design and Implementation Based on Quality Requirement". International Journal of Advances in Engineering & Technology, July. 2014.
[7] Leonard, Edward M. (2011) Design and Implementation of an Enterprise Data Warehouse. Paper 119. Available: http://epublications.marquette.edu/theses_open/119.
[8] Sauter, Vicki L, "Decision Support Systems for Business Intelligence", John Wiley & Sons, Inc. Canada, 2010.
[9] Kimball, Ralph., Ross, Margy, "The Data Warehouse Tool Kit", John Wiley & Sons, Inc, Canada, 2013.