Design of Integrated Data Management System for Sustainability Reporting and Program for Manufacturing Industries in Indonesia

Priskila Christine Rahayu[a*], Daisy Amanda[a], Jessica Hanafi[a]

[a]Department of Industrial Engineering, Pelita Harapan University, Tangerang, 15811, Indonesia

First submission: 21th September 2017, Revised submission: 21th November 2017, Acceptance: 10th December 2017

Abstract

The manufacturing industry and its relationship with sustainable development simply cannot be separated. Especially, when the government started to show their attention by giving various obligations for the manufacturing industry to implement sustainable development principles, such as the obligation of the company to conduct a social and environmental responsibility by making sustainability report, the environmental impact assessment (AMDAL) report, to participate in various sustainability programs such as Corporate Performance Rating Program (PROPER) and Green Industry Award. There are so many indicators and data that need to be collected in order to fulfill these obligations. It certainly may charge the company in terms of time, yet the number of indicators and the data required were similar between one report to another. There is still no particular design to be able to resolve the issue. Therefore, the aim of this study is to design an integrated data management system for sustainability reporting needs and sustainability programs which has the end result of an application prototype of a system that can help companies, especially in the manufacturing industry to create reporting even more efficient. Data management is done by combining all four types of reporting and program which are Global Report Initiative sustainability report, the AMDAL report, Green Industry program, and PROPER. The prototype is made based on the results of data management using Microsoft Access to store data and to produce four types of summary reports. In the end of the study, it can be concluded that, overall, the system can be implemented and by the withdrawal of three respondents review, the system can improve the efficiency of the company in preparing sustainability reporting. In the evaluation phase, it is found a related method that can be used as the basis to do before making reporting in order to make them more easily 40.98%, that is Life Cycle Assessment.

Keywords: *Integrated Database Management System; Life Cycle Assessment; Sustainability Report; Manufacturing Industry*

* Corresponding author. Tel.: +6221 5460901
priskila.christine@uph.edu.

1. INTRODUCTION

Industry in Indonesia, especially the manufacturing industry, is one of the largest contributors to the advancement of the Indonesian economy. There is problem that can never be stopped which is about competitiveness. People are increasingly selective in buying a product by considering aspects of sustainability.

In order to support the sustainable development, manufacturing industries in Indonesia begin to fulfill the obligations imposed by the government to prepare and join sustainability report and program, with environmental aspect as the evidence that the company has demonstrated the concern for the environment. The report and the program form a wide range. But, there are many similarities to the indicators and data requirements of the reports and programs. The similarities between the indicators and required data of the sustainability reports and programs deemed to be less efficient because the company's staff should collect similar data repeatedly that takes time, so it needed a special design to allow companies to prepare those reports and preparation for participating in the program all at once.

From the problems explained above, the purpose of this study was to design an integrated data management system that is an integration of indicators and required data of each report so it can increase the efficiency and it can accelerate the process of preparing the sustainability reporting and programs. The system will consist of integrated data management and an application of integrated data management prototype. The goal function of the system is to be able to store data needed to make several sustainability reports and can provide a list of data requirements for sustainability programs..

The scope of the research is that it is only specialized the discussion particularly in sustainability document of environmental aspects which are required by the Indonesian government to the manufacturing industry[1]. The reports and programs are GRI corporate sustainability report, the AMDAL (or Environmental Impact Assessment - EIA) report, PROPER, and Green Industry awards [2-6].

2. METHODS

This study begins by collecting data such as indicators, criteria, and the types of data requirement of environmental aspects to conduct the sustainability reports and/or the preparation to follow the sustainability programs.

The data consists of various sub-aspect such as the use of materials, energy, water, emissions and waste produced, efforts to control the environment of emissions and waste generated, etc.

The data is collected through the study of literature from various sources such as guidelines for the preparation of sustainability reporting and programs, books, journals, articles and the official website of the organization on the internet.

When the data has been collected, the next step is processing the data so it is able to design the data management system that contains the collected data.

Data that has been collected next will be processed with the integration method by combining and searching for the incision if there is a relationship and similarity of the data required and indicators of the sustainability reports and programs.

The data management is divided into two, they are primary data management and secondary data management.

The next step is designing the data management system by adapting all the primary and secondary data management into computer applications in prototype form. Before the prototype application is created, the system concept first must be designed.

The design steps itself is divided into five which are designing the general concept of integrated data management system, designing the detail concept of integrated data management system, designing the menu structure and prototype application interface, designing the receiving data concept or reports produced from the system, and building the prototype application of integrated data management system by realizing the designed results using Microsoft Access 2010.

After the prototype has been built, it has to be tested to operate the prototype into the actual circumstance. The testing is done by inputting the data inventory of company's sustainability to meet the indicators and criteria that has been designed in the data management system previously.

The last phase is testing that is done by demonstrating the system to some manufacturing industries in Indonesia. Then some questionnaires and the review about the system will be taken tobe used for the evaluation phase.

3. RESULTS

According to the methods, the following results are obtained:

3.1. List of Indicators and Data Requirement of The Sustainability Reporting and Programs

Before it is able to combine and compile the data to become an integrated data management system, it is a must to make list of the indicators and data requirements of each report and program. Each report contains several aspects as shown in table 1[11].

Table 1. List of the number of aspects and indicators of each type of reports

Type of Report	Amount of			
	Aspect	Sub Aspect	Indicator	Sub Indicator
GRI	10	-	34	105
AMDAL (AM)	5	-	14	-
PROPER(PR)	4	-	15	32
Green Industry (IH)	3	14	36	87

There are similarities in the indicators and data requirements of the four reports including covering the use of materials, energy, water, emissions and waste produced, efforts to control the environment of emissions and waste generated, etc.

3.2. Primary Data of Integrated Data Management

As stated before, the design of integrated data management is divided into two stages: design of primary and secondary integrated data management. Primary data management is 166 data that must be collected by the company's admin from 14 aspects as shown in table 2.

Table 2. List of Primary Data

No	Aspect	Amount of Indicators
1	Material	8
2	Production Process	19
3	Energy	10
4	Water	19
5	Biodiversity	15
6	Emission	16
7	Waste	28
8	Products and Services	11
9	Transportation	1
10	Supplier	5
11	Documents, Reports, and Licenses	14
12	Environment Impact	11
13	Employees	5
14	Other Environmental	4

Meanwhile, the secondary data management is derived from primary data, or can be said as data requirements too that can be generated once the primary data has been collected. There are 6 aspects with 22 indicators obtained from the relation between/among primary data indicators as shown in table 3.

Table 3. List of Secondary Data

No	Aspect	Amount of Indicators
1	Material	3
2	Production Process	1
3	Energy	9
4	Water	3
5	Emission	5
6	Waste	1

Secondary data is data that needs to be as well to meet the reporting and programs requirement. The secondary data may be generated from the primary data, in other words, secondary data is derived from the primary data. With the secondary data, the admin does not need to collect data anymore, simply by making certain processing to the primary data that will generate secondary data. The certain processing data could be addition, multiplication, division and subtraction.

In this discussion will be limited to material aspects. The material aspect has primary data management as shown in table 4.

Table 4 Primary Data Management of Material Aspect

Data	No	Reports and Programs			
		GRI	PR	IH	AM
Volume of nonrenewable material used	DP1	√			
Volume of renewable material used	DP2	√		√	
Volume of recycled material used	DP3	√		√	
SDS (material safety data sheet), certificate, and license/material	DP4			√	
Document of material input used	DP5			√	
Material purchase invoice	DP6			√	
Data of material reception	DP7			√	
SOP of material input processing	DP8			√	

Then the primary data of material aspect processed into secondary data as shown in table 5, as many as 3 data from 23 overall secondary data.

Table 5. Secondary Data of Integrated Data Management – Material Aspect

Data	No Indicator	Relation	
Volume of materials (total)	DS1	Volume of non renewable material + volume of renewable material	DP1+ DP2
Material used efficiency	DS2	Total of annual production / Volume of materials (total)	DP13/ DS1
Material used intensity	DS3	Volume of materials (total) / Total of annual production	DS1/ DP13

The twenty three data and/or indicators that have similarities with each other in the primary data compared to the amount of data and indicators on primary data is 18 data for 2 similarities, 1 data for 3 similarities, 1 data for 4 similarities, 1 data for 5 similarities, 1 data for 6 similarities and 1 data for 10 similarities.

This number explains that there are 18 data that used to be input twice can be input for only once which means the time required to collect 18 data to meet the needs of two reports as well as one will be faster compared to collecting twice (it happens to the 3 and more similarities as well).

Meanwhile the amount of secondary data when compared with the overall data and indicators (primary data plus secondary data) is 23/188. This indicates that the data can be obtained without performing the collection, just by performing certain processing of the primary data as much as 23.

It can be said that the amount of input data with the amount of time required to input data has a linear relation, ie the smaller the amount of input data then smaller the amount of time required to input data.

3.3. Data Management System Design

At this stage the concept of the data management system (which results an application prototype in the form of Database Management System) will be designed [7-9, 13].

1. Design of the general concept of integrated data management system.

The concept of how is the process going to be will be described globally in the form of a flowchart. This stage aims to explain widely to user about the functions planned for the integrated data management system for sustainability reporting and program as shown in figure 1.

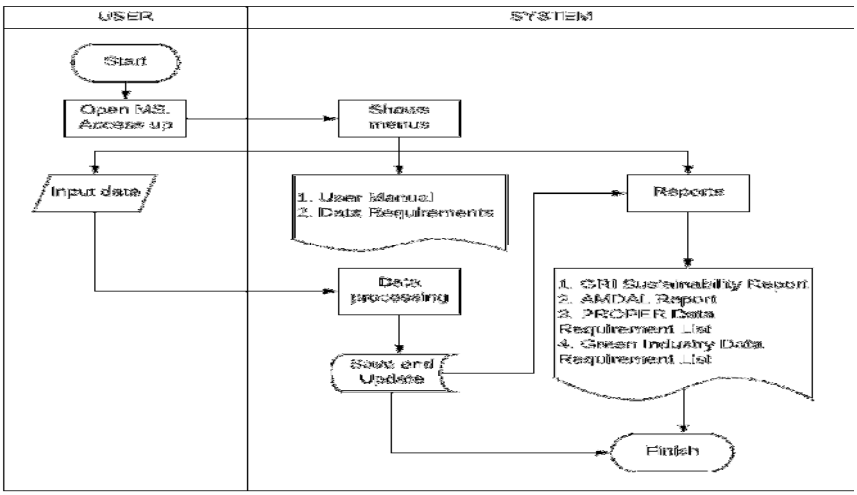


Fig. 1. Flowchart of Integrated Data Management System for Sustainability Reporting and Program

2. Design of the detail concept of integrated data management system.

The next design stage is for the detail concept, which consists of the tables and the queries needed in the system. Tables are made as the data storage that constructed from the primary data and queries are made out the other primary or secondary data.

The material aspect has 3 tables and 5 queries that are:

a. table description has 16 fields to store data of material by name every year with primary key (PK) year and material code.
b. table document has 6 fields to store document every aspect with PK material doc (1/14 total aspects).
c. table document list, to store list of material document that must be collected
d. three query to manipulate data of material in sequence if system wants to display records

based on status renewable, irrenewable, or can be recycled in the last report

e. select query to manipulate data if system want to display last purchase invoice

f. query to manipulate data when system want to display certificate of each type of material

3. Design of the menu structure and prototype application interface

Before it is able to design and make the forms or application prototype's interface, it is a must to set up a menu structure at first so it can be easier. The menu has 5 choices: General Company Data, Input Data for all aspects, Sustainability Report with 4 choices, How to use The Application, and Data Reporting Needs. When the menu structure is set up, the next stage to do is designing the application prototype's interface (only for material aspect).

4. Design of reports produced from the system

All the reports that are designed is the result of the data input process that has been done before, there is also a result of data processing that is performed by the queries that have been made. As stated previously, the query can help the processing of some of the data for reporting. Queries that are used the most for GRI sustainability report's summary that related to the format of the report that is showing the data per year (last three years) horizontally.

Therefore the crosstab queries are needed so they can cross the 'year' from value form (row) into field names (column).

5. Building the prototype application of integrated data management system

After all the required components of the prototype have been designed, then it is able to build the prototype of integrated data management applications by applying and adjusting the results of the design concept of the system. The prototype was created using Microsoft Access software as shown in figure 2 until figure 11 .

Fig. 2. Display of Home Page Menu

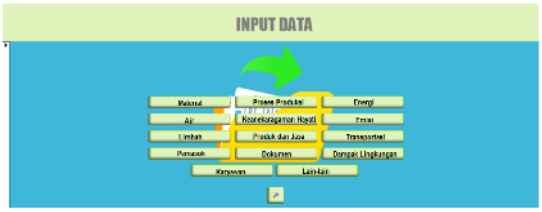


Fig. 3. Display of Menu Input

Fig. 4. Display of Data Input Material Aspect Form

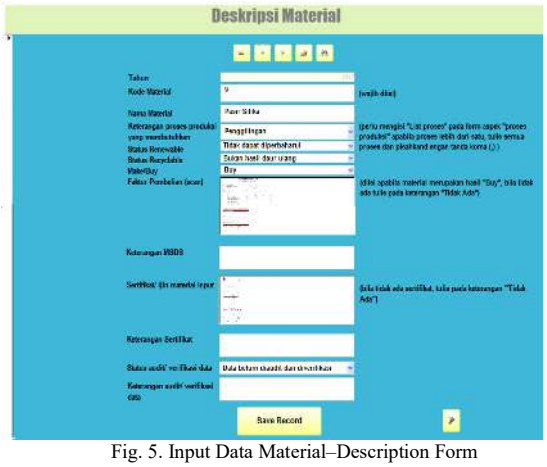


Fig. 5. Input Data Material–Description Form

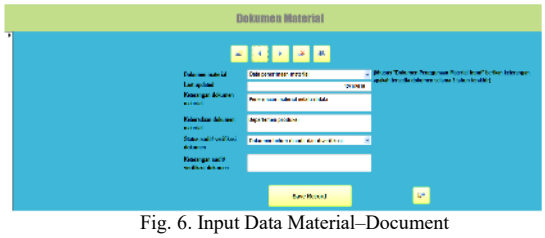


Fig. 6. Input Data Material–Document

Fig. 7. Menu Sustainability Report


PT SEMEN XYZ

Tuesday, December 20, 2016

SUSTAINABILITY REPORT 2017 (Bag. 1)

GRI	Keterangan	Satuan	Penjelasan	2015	2016	2017
	MATERIAL					
G4-EN1	*Material yang digunakan untuk memproduksi dan mengemas produk yang dihasilkan*					
	Material tidak dapat diperbaharui:					
	Bahan kemasan - kertas	juta ton		.03	.01	.02
	Gamping	juta ton		9.17	10.14	9.78
	Lempung	juta ton		1.2	1.3	1.4
	Pasir Silika	juta ton		.43	.42	.49
	Material dapat diperbaharui:					
	Copper Slag	juta ton		.10	.1	.1
	Fly ash	juta ton		.20	.2	.2
	Gypsum	juta ton		.30	.3	.3
G4-EN2	*Total input material daur ulang yang digunakan*					
	Material daur ulang:					
	Bahan kemasan - kertas	juta ton		.03	.01	.02

Fig. 8. Display of GRI Sustainability Report Summary

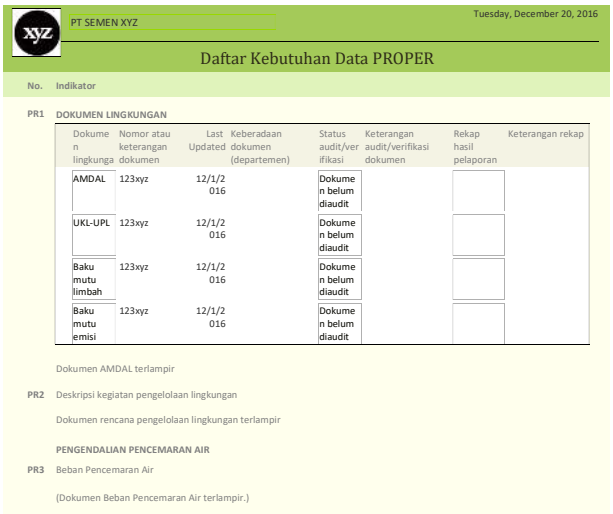

PT SEMEN XYZ

Tuesday, December 20, 2016

Daftar Kebutuhan Data untuk Program Penghargaan Industri Hijau (bag. 1)

No.	Indikator/Kebutuhan Data				
	PROSES PRODUKSI				
	PROGRAM EFISIENSI PRODUKSI				
	Kebijakan Perusahaan dalam Penerapan Efisinsi Produksi				
IH1	*Dokumen Kebijakan*				
	Last updated	Lokasi dokumen	Status audit/verifikasi dokumen	Keterangan audit/verifikasi dokumen	
	9/6/2016	Departemen HRD	Dokumen belum diaudit dan diverifikasi		
IH2	*Program Penerapan Efisiensi Produksi dan Laporan Hasil Pemantauan dan Evaluasi Program*				
	Nama program	Laporan hasil pemantauan	Laporan hasil evaluasi	Status audit/verifikasi	Keterangan audit/verifikasi dokumen
	Program Efisiensi Produksi - 1	☑	☑		
	Tingkat capaian penerapan program sesuai dengan komitmen perusahaan dalam meningkatkan efisiensi produksi				
IH3	*Dokumen proses produksi: Laporan kegiatan produksi*				
	Dokumen proses produksi	Last updated	Keterangan dokumen	Status audit/verifikasi dokumen	Keterangan audit/verifikasi dokumen
	Laporan kegiatan produksi	12/1/2016		Dokumen belum diaudit dan diverifikasi	

Fig. 9. Display of Green Industry Data and Document Requirements List Report

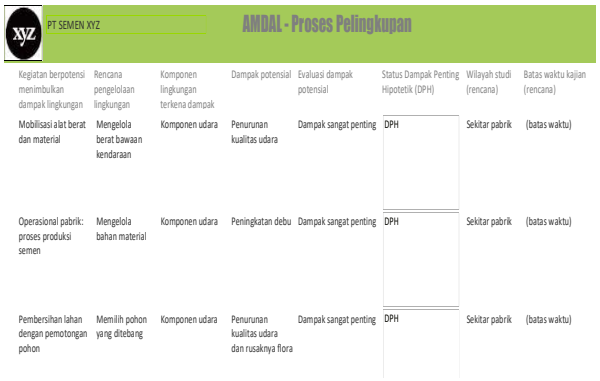

PT SEMEN XYZ

Tuesday, December 20, 2016

Daftar Kebutuhan Data PROPER

No.	Indikator							
PR1	DOKUMEN LINGKUNGAN							
	Dokumen lingkungan	Nomor atau keterangan dokumen	Last Updated	Keberadaan dokumen (departemen)	Status audit/verifikasi	Keterangan audit/verifikasi dokumen	Rekap hasil pelaporan	Keterangan rekap
	AMDAL	123xyz	12/1/2016		Dokumen belum diaudit			
	UKL-UPL	123xyz	12/1/2016		Dokumen belum diaudit			
	Baku mutu limbah	123xyz	12/1/2016		Dokumen belum diaudit			
	Baku mutu emisi	123xyz	12/1/2016		Dokumen belum diaudit			
	Dokumen AMDAL terlampir							
PR2	Deskripsi kegiatan pengelolaan lingkungan							
	Dokumen rencana pengelolaan lingkungan terlampir							
	PENGENDALIAN PENCEMARAN AIR							
PR3	Beban Pencemaran Air							
	(Dokumen Beban Pencemaran Air terlampir.)							

Fig.10. Display of PROPER Data and Document Requirements List Report


PT SEMEN XYZ

AMDAL - Proses Pelingkupan

Kegiatan berpotensi menimbulkan dampak lingkungan	Rencana pengelolaan lingkungan	Komponen lingkungan terkena dampak	Dampak potensial	Evaluasi dampak potensial	Status Dampak Penting Hipotetik (DPH)	Wilayah studi (rencana)	Batas waktu kajian (rencana)
Mobilisasi alat berat dan material	Mengelola berat bawaan kendaraan	Komponen udara	Penurunan kualitas udara	Dampak sangat penting	DPH	Sekitar pabrik	(batas waktu)
Operasional pabrik: proses produksi semen	Mengelola bahan material	Komponen udara	Peningkatan debu	Dampak sangat penting	DPH	Sekitar pabrik	(batas waktu)
Pembersihan lahan dengan pemotongan pohon	Memilih pohon yang ditebang	Komponen udara	Penurunan kualitas udara dan rusaknya flora	Dampak sangat penting	DPH	Sekitar pabrik	(batas waktu)

Fig. 11. Display of AMDAL Report Summary

3.4. Testing

Testing stage is the stage where the system will be operated on the actual circumstances, so it will be known whether the system that has been created can really run and in accordance with the objectives to be achieved or not. Due to time constraints of the study, the data that will be inputted into the system during the testing phase is dummy data (data example), which means the data is borrowed from certain sources. The manufacturing industry that will be the object of testing stage is the cement manufacturing industry[10].

The testing overall can be stated as successful because mostly the functions can be operated smoothly. The only failure of the testing happens to the reporting of GRI report that will be explained in discussion section.

3.5. Testing Result

The system testing needs to be done, in order to be a tool to support the value of the reliability of the system design, testing is done to see if the system is feasible for use on the real situation by companies related, or not.

Testing is done by two manufacturing industries, namely PT Air Tech Inti Karawaci and PT Batara Krida Mega Kencana. Additionally, there was also feedback retrieval from a member of the Technical Commission Pustanlinghut-KLHK (Center for Standardization Environment and Forests - Ministry of Environment and Forestry).

The stages of testing to the manufacturing industry begin by interviewing the availability of data requirements and indicators of the sustainability report and program.

Then, identified in which report and program they're heading onto based on the availability of the inventory data. The next step is to input the available data briefly into the application along with doing the prototype demonstration. Once the demonstration is done, the respondents then are given the questionnaire containing questions about the application prototype that has been built.

Table 6. Testing Result

No	Question	Parameter	Average
1	Is the application's interface display in well order and clear?	Design	7.25
2	Is the data that needs to be collected can meet the reporting requirements?	Comprehensive	7.25
3	Is the report result matched with the data that has been inputted?	Inputted data corresponding to the real report	8.25
4	Is the report result has met to the original report format?	Report representation	7.33
5	Is the use of this system able to shorten the time taken to build such reports?	Efficiency	8.50
6	Is the system overall easy to use?	Easy of use	7.75

According to the table, which has been shown above, it can be seen that the lowest average value from three respondents is 7.25 which refers to the design parameters.

That can be caused by the design that is not emphasized in this study, but other parameter. Another lowest average value goes to comprehensive parameter (7.25). Based on one of the feedbacks given, explained that there is data that has not been updated from a latest list of data requirements, namely PROPER program (which will be discussed further in discussion section). So that the values given indicate that the level comprehensively not maximized.

The highest average value which is 8.5 is obtained from the parameter "Efficiency" The three respondents agreed that this prototype application can save time in preparing and making sustainability reports and programs environmental aspects.

In addition, the second highest average value obtained by parameter 'Ease of Use' the reason why the parameter gets top marks allegedly caused by a low effort that needs to be done by the admin to prepare four reports at once. Additionally, the application does not require special skills activity or as complex as an example, calculations. So the prototype can be said as easy to use.

4. DISCUSSION

Once the prototype is made and completed through testing and review collecting process, as has been stated before that there are a number of things that are not capable to run as has been designed. The results of evaluation that refers to the system deficiencies based on the results of testing, first, GRI sustainability report that has been created can only report the results of the data for 2017 which GRI sustainability reporting used to be able to show data from all years as desired. It relates to the crosstab query function that can not update the years to become the title of the column or field name in the report.

In addition, in order to update the year, it requires complex data relationships and can take a long time. However, the problem is said to be minor problems because it does not affect the process of demonstration systems. One solution that can be done is to continue to update once the application is published every year about the arrangement of crosstab query. However, it would be nice if the GRI sustainability report can show the desired years without an update every year. Therefore, it is needed to in-depth expertise in programming and database management especially the relationship so the feature to show the desired year can be realized.

The explanation just presented an evaluation of technical terms. The next evaluation is the result of suggestions and review given by the respondent. Third of respondents stated that the application as a whole can help companies in preparing and making the report and prepare the data for more efficient sustainability program.

However, one of the results of the review stating that the PROPER data requirement list that is contained in this report are not yet using the the latest data requirements contained in the Regulation of the Minister of Environment No.3 year 2014, while this report uses the list of data requirements based on the report format PROPER year 2013.[1],[3] However, regarding this matter, it can be assumed that there is no big difference to the format of the report in 2013 compared to the year 2014. However, to realize the prototype into the application to be published, it is necessary to use the data for the latest PROPER to prevent reporting errors.

The last evaluation will be discussed associated with this system is about the big amount of data that must be collected from the four types of reports. To solve the problem, it's necessary to know whether there is a master data base or data collection by doing that basis, can easily fill the entire data requirements to be collected.

After going through the selection process to meet the results of the evaluation, it was determined that there is a sufficient appropriate method, namely Life Cycle Assessment (LCA).

This approach has similarities with the objectives from the four reporting and programs that are discussed in this study. To be able to see the similarity and suitability of the relationship between the LCA and the four reports, each of data and indicators that should be collected from the four types of reports that are discussed in this study

are being connected with the data requirements of LCA.

There are actually 15 aspects that have connection and relation with LCA, but only two aspects that will be shown which are the material and production process aspect from the primary data management that has been created previously [12-13].

Table 7. Relation with LCA

Aspect	Data	No. Indicator	Relation with LCA
Material	Volume of non renewable material used	DP1	Known inputs from technosphere or nature
	Volume of renewable material used	DP2	Known inputs from technosphere or nature
	Volume recycle material used	DP3	Known inputs from technosphere or nature
Production Process	Production activity report	DP11	Process documentation
	Total production	DP13	Known inputs from technosphere
	Machine specification	DP21	Known inputs from technosphere (electricity and heat), additional info to process documentation
	Operating hours of the machines	DP22	Known inputs from technosphere (electricity and heat), additional info to process documentation
	Total reject and defect products	DP23	Known output to technosphere-avoided products
	Total scrap product	DP24	Known output to technosphere-avoided products
	Total rework product	DP25	Known output to technosphere-avoided products

From the table above, it can be seen that a lot of data and indicators that are connected to each other. There are total 68 data from 166 primary data that are interconnected or 40.98%. It explains that by conducting LCA studies before, the company has been collecting primary data as much as 40.98% to be used as a GRI sustainability report, a list of data requirements for PROPER, list of data requirements for the Green Industry, and the AMDAL report. It indicates that the LCA method is a suitable method used as the basis or source of master data in preparing four types of reports which have been answered on the evaluation of integrated data management system for reporting needs and program sustainability.

5. CONCLUSIONS

Based on the results of design of integrated data management system from the four reports, obtained some similarity of data in 166 primary data. Also obtained 11.7% of secondary data that can be generated from the primary data. While data management through LCA obtained 40.98% from the primary data.

Thus the admin of a company having work efficiency does not have to process data as much as 11.7% of the total indicator report.

The prototype of an integrated data management application has been successfully created to produce two sustainability reports and two lists of sustainability program data requirements, namely the GRI sustainability report, AMDAL report, data requirements list report for green industry programs, and a list of data requirements for PROPER.

The results of the questionnaire from system testing state that using an integrated data management system for sustainability reporting form three users, states that the system can save time and increase efficiency. Thus, through an integrated data management system, the desire of manufacturing industries to implement the principles of sustainable development can develop.

REFERENCES

[1] Undang-Undang Nomor 3 Tahun 2014 tentang Perindustrian.

[2] Global Reporting Initiatives. G4 Sustainability Reporting Guidelines. Amsterdam: GRI, 2013.

[3] [3] Kementrian Lingkungan Hidup. "Peraturan." Peraturan Menteri no. 6. Jakarta: Kementrian Lingkungan Hidup RI, 2013.

[4] Peraturan Pemerintah Nomor 16 Tahun 2012 Tentang Pedoman Penyusunan Dokumen Lingkungan Hidup.

[5] PROPER.2016. http://www.menlh.go.id/proper/ (diakses September 26, 2016).

[6] Kementrian Perindustrian Republik Indonesia. Pedoman Penilaian Penghargaan Industri Hijau. Jakarta: Badan Penelitian dan Pengembangan Industri, 2016.

[7] Intra-governmental Group on Geographic Information. The Principles of Good Data Management. London: Office of the Deputy Prime Minister, 2005.

[8] Taufani, Dani R. Mengolah Data dengan Microsoft Access 2007. Bandung: Microsoft User Group Indonesia, 2009.

[9] The University of Reading. Microsoft Access 2013™ An Essential Guide. Microsoft Corporation, 2016.

[10] PT. Holcim Indonesia, Tbk. "2014 Sustainable Development Report."2014.

[11] KPMG. Survey of Corporate Sustainability Reporting. Swiss: KPMG International, 2015.

[12] ISO. Environmental management - Life cycle assessment - Principles and framework. Switzerland, 2006.

[13] ISO/IEC/IEEE. Systems and Software Engineering. Switzerland: ISO, 2010.

[14] [14] Connolly, Thomas, and Carolyn Begg. Database Systems. Edinburgh: Addison Wesley, 2010.

[15] Elmasri, Ramez, and Shamkant Navathe. Database Systems. 6th Edition. Massachussets: Pearson, 2011.