Monograph

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PREFACE

Our environment is constantly changing. Pollution, global warming, natural resource depletion, loss of biodiversity, climate change, deforestation, ocean acidification and ozone Layer Depletion are major current environmental problems. Some regulation released to solve these problems. For example: Directive 2002/96/EC on Waste Electrical and Electronic Equipment and Directive 2002/96/EC on the Restriction of the Use of Certain Hazardous Substances in EEE (RoHS).

Reverse Logistic (RL) has become an important issue in industrial sector in the last decade. RL is one of methods to solve some environmental problems due to limited natural resources, e-waste, limited of recycled centers and disposal centers as the examples of serious environmental problems.

This paper presents of maturity framework to assess the level of RL implementation. The framework starting from many company claimed of successfully RL implementation. However, no clear key performance indicators, parameters, or assessment method is provided to measure it. Here, a maturity framework of RL may help the present status of their companies and give the opportunity to increase the performance.

CONTENT

FIGURES AND TABLES

Figures

Tables

CHAPTER 1

INTRODUCTION

The management of unused product, waste, and limitation of natural resources become growing concerns and popular issues throughout the decade. Good management of Reverse Logistics (RL) can be improve customer service management, environmental issues, economic benefits and sustainability of natural resources (Chouinard et.al. 2005; Lee and Dong, 2009; Aras et.al. 2011). In other hand, the important factors to meet the environmental standard, set product-specific and green environments are regulations and government policy (Schultmann et.al. 2006; Kumar and Yamaoka, 2007; Ilgin and Gupta, 2010).

The RL has been considered as one strategy to increasing company profit, concerning of environmental problems and decreasing product return. RL can be defined as "a process of company with planning, implementing and controlling ranging from inventory, finished goods and supported by the latest information to get a value or disposal" (Rogers and Tibben, 1998; Bernon et.al., 2011; Lambert et.al., 2011). Stock (2003) analyzes that RL will be one of the ways to reduce costs, increase revenue and customer service level and help to gain market benefits. The integration of RL system implementation with the right, fast and update information system will provide benefits in the form of collaboration and coordination system among all actors in the supply chain system (Chouinard et al., 2004). Moore (2005) reports the survey which conducted to 125 manufacturing companies gives a result that 50-70% of the total of company's potential revenue is derived from the re-remanufacturing process of end-of-life products into product quality which is produced almost as new. Pollock (2007) analyzes that the implementation of RL system can improve company performance, customer satisfaction, and organizational position. Based on recognition of the Steel Recycling Institute, 2006a in Kumar and Putnam (2008), the use of iron recycle gives profit impact of 74% for energy savings,

90% for use of natural resources, 97% for reduction from mining wastes, 88% for reduction of water emission , and 76% for water reduction. On the other hand, the existence and current strategic issues (technological innovation and IT) when adapted will help the company to implement better RL (Li and Olorunniwo (2008).) By comparing barriers and drivers, the barriers will be related to external environment (Lau and Wang (2009) will give great benefit for the company. Another benefit of the research by Rakesh Verma (2010) is asset utilization, asset recovery, profit maximization, to fulfill the environmental obligations and customer relations management, while Olorunniwo and Li (2010), state that sharing information with all actors within RL will help to improve the company's performance. The benefit of RL operation conducted by Wrap (2010) will have significant impacts such as effective waste management, cost, carbon impact, health, and safety. In addition to some of the above benefits, it can also be added to the implementation of this RL system that will be able to determine the company's strategy in accordance with the characteristics of each company. This is because the implementation of each company's RL system is not necessarily the same depending on: product produced, availability of resources amount both human resources and biology, company policy, government policy, characteristics and behavior of consumer, availability of the latest information (market segment, supplier, outstanding products, and technology) and strengths and weaknesses of the company that will implement the RL system. Ramírez, (2012) and Silva et al., (2013) reported to improve the value of products, improve business performance, fulfill the increase of number environmental regulations and to fulfill legislative issues, RL has played an important role in a number of manufacturing firms.

Prahinski and Kocabasoglu, (2006) and Kocabasoglu et al., (2007) reported that many activities can be classified as RL system. The returned product is generally collected from the point of the sale, inspected and sorted by employees or to retrieve a product from customers are example of RL activities. However, De Brito et.al

(2005) reported other causes of RL activities i.e. end-of-use return and end-of-life return, manufacturing return, commercial return, product recall, warranty recall, service return. Finally, the RL activities in Indonesia caused from defective product, malfunctioned product, warranty product, product recall, unsold product, and expired product.

The RL has been successfully implemented in some companies. The purposes of RL implementation are to waste minimizing waste and use of natural resources, increasing product life-cycles, supply chain complexity, customer satisfaction and loyalty. However, no clear key performance indicators, parameters, or assessment method is provided to measure the successful level of RL implementation. Balan et al (2006) reported that assessing tools are needed to make new strategies or approach gain competitive advantages. Here, a maturity framework of RL may help the present status of their companies and give the opportunity to increase the performance. RL operations are significantly more complex than traditional manufacturing (Amini et.al, 2005). Every process requires a lot of activities, actors, and costs. Therefore, the success of RL implementation comes from many aspects. Maintaining customer satisfaction and maximizing speed of production and product lifecycles, reducing expenses, and minimizing waste are some examples of the aspects. In addition, the use of secondary material for minimizing natural resources is another aspect. Every company that implements the RL should have criteria or parameters to measure the RL level of success.

In other hand, maturity concept can defines as a conceptual model that consists of a sequence of discrete maturity levels for a class of processes in one or more business domains, and represents an anticipated, desired, or typical evolutionary path for these processes (Becker et al., 2009). Process maturity concept assumes that the implementation of procedures is carried out in multiple evolutionary and successive stages (Fischer et al., 2016). Maturity concepts have been developed to construct the maturity of RL implementation. A maturity level indicates precisely a level of

capabilities that an organization may have such that it has been obtained through the transformation of one or more sections of organizational processes (Khatibian et al., 2010).

In this book, maturity level of RL can be assumes that there are successive stages in the RL implementation and the stages indicate how the process explicitly can described, implemented, assessed and controlled. To fill this gap, the book proposes the development a framework for evaluation the maturity level of RL implementation. Hence, the maturity level of RL has many benefit i.e.:

1) Will help to waste and pollution, and anticipating the lack of natural resources.
2) Fulfilling the global environmental obligation.
3) Maximizing the company profit
4) Helping company to measure the RL implementation based on the RL Key Performance Indicators (KPI)
5) Being a learning process for the company to raise the level of its RL implementation with several strategies adapted to the company's condition
6) Providing an overview of indicator and target which shall be achieved by the company in each level

CHAPTER 2
GROUNDED THEORY

Grounded Theory (GT) approach is used in the process of preparing this framework. In GT, there are several steps that must be taken to analyze and infer the existing events.

2.1 Grounded Theory Concept

According to Glaser and Strauss (2006), in their book entitled "*The Discovery of Grounded Theory*" which has undergone several prints from 1967, it has been explained that GT is a theory derived from the result of inductive thinking in a research about phenomena occurring in the field. Heath and Cowley (2004), Walker and Myrick (2006), Bernon et al (2011), and Denk et al (2012) have drawn conclusion from Glaser & Strauss, that GT is "*Research methodology findings emphasize the qualitative theory of observation data in the field with empirical inductive method (the theory of amount of data), which is the discovery or construction of generative theory using the data as evidence*". GT is a data theorization. The data theorizing is a method of preparing action-oriented theory/interaction/process that actually occurs in the field.

This research is based on a theory that aims to examine how the implementation occurs in the field. The theory produced must be in accordance with the procedure and plan as well as the systematic. The method is discovered, developed and proven through a systematic data collection process and data analysis of existing phenomena. Therefore, the data collection, analysis, and theory will affect each other.

The GT research gives the researcher the ability to derive or create a theory in the context of data that has been collected. Strauss & Corbin 1990 in Wardhono (2011) describes that GT is a theory derived from data that is systematically collected

and analyzed and the data comes from observation process in the field. The difference between the GT method and the other method is on the philosophical approach, namely the continuous relationship between data collection and data analysis. Figure 2.1 below describes the process of induction, deduction, and verification on GT theory. From the data found in the field up to the questions expressed to build a theory.

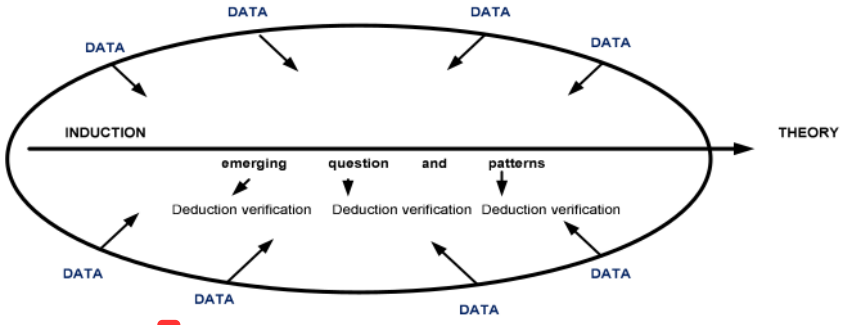

Figure 2.1 Place of induction, deduction dan verification in grounded theory analysis

Source: Glaser (1992)

Framework Maturity Design of RL is developed from the GT approach. With so many evidence of RL implementation, although it is very simple, then a new theory can be generated. The induction process is an important step for a researcher to examine the existing data into a theory. Based on the research of Heath and Cowley (2004), imagination and creativity of researcher are very helpful to bring out a new theory. A data is used to solve a problem. This makes a new theory more plausible. GT will also be able to recognize not only an analytical generalization but also statistical generalization so that the established theory will be very precise to the problem that occurs (Bernon et al, 2011). Randall and Mello (2012) report that the ability of GT is to overcome behavioral dimensions at the individual, organizational and inter-organizational level. Another benefit that can be obtained from this GT is that GT is able to evaluate the stiffness and credibility of a theory so that it is more flexible (Manuj and Pohlen, 2012).

2.2 Purposes of GT

The purposes that will be achieved by applying GT as an approach method, namely:

1. Producing or finding a theory, an abstract analytical schema of a phenomenon associated with a particular situation. The intended situation is where individual interacts, performs activity, action, or performs a process that is a response to the happening phenomenon. While the phenomena are the main idea, incident, event, or incident in which a set of actions or interactions are directed, managed, or handled contextually related to the set of actions. To examine the above matter, then a researcher must do direct interaction either direct observation in the field, interview to the interested party while matching between one data with the other and looking for a systematic relationship between them. The more data collected, the better the conclusion and the theory.
2. Conducting empirical generalization, establishing concepts, proving and developing theory.

   The method used in GT is comparative studies aimed at determining the different cases or symptoms that occur. The researcher needs to compare the symptoms/cases with similar cases/symptoms. This comparison will explain the new elements of the research originality being conducted.

2.3 Stages of GT

In order to have more systematic and structured research, then the process of data collection conducted in the field or not must have a separate mechanism. This aims to avoid too large bias between one data with the other. Thus, among the data will be able to support other data to bring out a new theory. There are 4 stages those are:

1. Data Collection Phase

The first step is data collection phase. In this phase, a literature review of all RL-related research is conducted to find out the advantages and disadvantages of RL implementation. In addition, the benefits obtained by company and environment will be implemented in this phase. Choosing the right case and structured data collection process will help to get the necessary data.

2. Data Compilation Phase

   In this phase, Open Coding and Axial Coding process are carried out. It is obtained the result of determining the parameter or things that influence the success rate of RL in the Open Coding. While open coding process is the process of interpretation of RL implementation that occurs in the company.

3. Data Analysis Phase

   In this phase, the framework of reverse logistics maturity has been established. In addition, the framework has been equipped with a parameter for each level.

4. Literature Comparative Phase

   In this stage, the advantages and disadvantages of the framework design that have been formed are presented. The existing disadvantages are used for the preparation of advanced research.

More complete steps in GT are divided into 10 processes cited by Randall and Mello (2012). Although GT is divided into 10 processes the objective that will be achieved is still same, namely generating a new theory of phenomena that occur in the field.

1. Step 1 and 2, the researcher should explain the problem, build research question and identify the sample. Starting from the system, methods, production process, strategic, criteria and evidence that can explain the implementation of RL that occurs. The data can be obtained from the direct interview, direct observation, primary and secondary data.

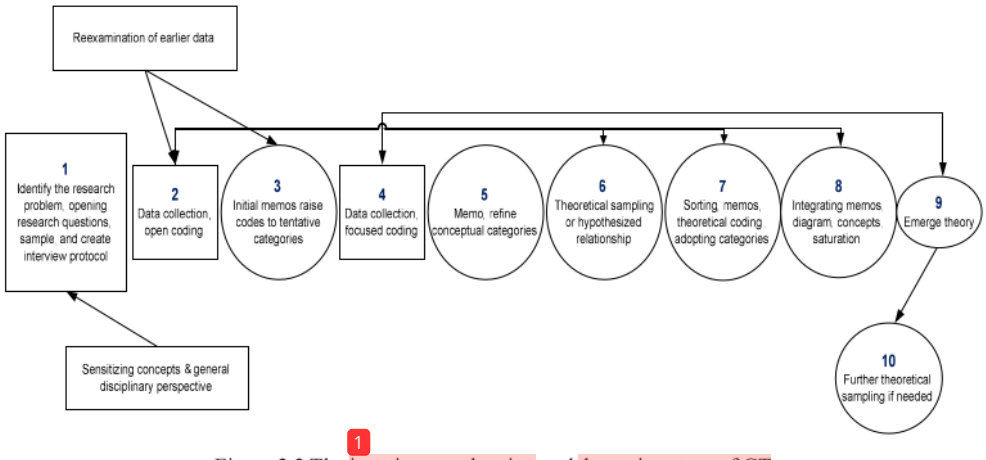

Figure 2.2 The iterative, overlapping and dynamic nature of GT

Source: Randall and Mello (2012)

2. Steps 3, 4 and 5 are the process of memoing. The purpose of the memoing process is to capture the thought and decision that lead to the emergence of a theory (Randall and Mello, 2012). The memo is also used to capture ideas about the researcher's direction in which he should take the next step by looking at development in the process of thinking about a theory during the study (Randall and Mello, 2012)
3. Step 6, this sampling theory is useful for finding a statement, event or case that can provide dimensional illustration and positive and negative examples of each category
4. Steps 7, 8, and 9. The data and the new interview will result in more focused research direction. Each category is researched and observed by seeing the synergistic relationship for generating new theories. The process of constant comparison provides a categorical definition so that the theory appears (Randall and Mello, 2012). Finally, the end of this process is a new theory. This theory explains phenomena in the field, process, criteria, and parameter, problem and how to fix them.
5. Step 10 is to apply the new theory to a problem that occurs. Thus, it will be known between the advantages and disadvantages of the theory.

The process of forming this framework involves several participants, among others: researcher him/herself, company, experts in the field of RL, the government along with its regulation and consumer. The five area processes come from review literature and group discussion. The following is the process of preparing framework with GT approach.

2.4 A Development of a Framework for Evaluation of Reverse Logistics Maturity Level with GT approach

The process of GT to construct conceptual framework maturity level of RL consists of four phases: Data collection Phase, Organizing Data Phase, Data Analysis Phase and Comparative Literature Phase.

2.4.1 Data collection Phase

The first step that must be conducted is the data collection phase. Data collected were tailored to the objectives to be achieved.

2.4.1.1 Review on Technical Literature

A review of the technical literature was done so that the research conducted has novelty and practical contribution. So the technical literature was collected and analyzed to confirm that our research has not been conducted previously by other parties or researchers. In addition, another goal is to see the extent of the research with the same scope. Within 1990 to 2008, the studies have ranged in scope RL Input, RL Structure, RL Process and RL Output. Within 2008 to 2016, the scope has begun to enhance. The coverage area includes some issues such as customer satisfaction, secondary materials, pricing, and waste and environment sustainability. In 2011 till now, issues such as framework, flexibility, corporate social responsibility (CSR), waste, policy (company, government, global), secondary materials and sustainability environment have their focus of study.

2.4.1.2 Selection of Case

After the review of technical literature compared with existing phenomena or events, the next phase is the selection of cases. This selection is intended to maintain the value of renewal upon the existing research. The selected cases are likely the up to date issues that exist around daily life so that this research will be able to solve the existing problems faced by the society. That fact is, however, there are many companies have assumed or claimed that they have implemented their RL successfully. But as the time counts, there have not any methods, measuring instruments or a clear framework to measure the extent to which the level of success that has been achieved by the company.

2.4.1.3 Developing Data Collection Protocol

The next phase is to develop a data collection protocol. Systematic preparation would be helpful for the researchers to the systematic of a collection of data which is fundamental for the research. The data were taken from several sources as mentioned in Table 2.1 and they are classified into primary and secondary data, and the researchers observed directly to capture the phenomena that occur at the research site. The protocol can be seen in Table 2.1 below:

Table 2.1 Data Collection Protocol

	Framework Maturity Level of RL
	Data were collected from direct on-site observation, deep interview with decision makers and inquiry from the questionnaire
Primary Data	The utilization of secondary materials in production process
	Production process (inventory system, production system, and process)
	Overall procedures of RL (distribution center, service center, third parties services, collection center, recycled center and disposal center)
	Company Organization (vision and mission, strategy, stakeholder)

	Services procedures, claim procedures
Secondary Data	Analysis of the implementation level of RL
	The complexity of activities and actors of each level
On-site observation	Direct supervision on the research object (three companies: PT. PCB, PT. GMEI, and PT. SA)

2.4.2 Organizing Data Phase

Data collection phase consisted of two coding, namely open coding and axial coding.

2.4.2.1 Open Coding

Open Coding: processes such as detailing, testing, comparing, conceptualizing, and categorizing the data. Besides, there are labeling the phenomena and the naming of these categories so that the process of grouping events can be clustered clearly as shown in Table 2.2

Table 2.2 ***Open Coding***

Coding	Explanation
A.1	Categorizing the level of success of the implementation of RL conventional level, managed level, developed level, innovative level, optimized level)
A.2	Categorizing aspects of RL (level of success of RL can be observed from some aspects, namely: information technology, production planning, distribution, business process and environmental)
A.3	Categorizing the indicators of success of the implementation of RL: (In addition to some aspects of the assessment references, more detailed indicators are needed in order to make a more thorough assessment of the implementation of RL. The indicators used in this study were 21 indicators which are divided into five aspects.)

2.4.2.2 Axial Coding

Axial Coding is identifying a central phenomenon, exploring the causal conditions, specifying strategies to identify context and conditions that may affect and describe the consequences of the phenomenon. In Table 2.3, it is explained the core problem (the root of the problem) should be discovered, and then there will be solutions offered and also the consequences that occur on these issues.

Table 2.3 Axial Coding

Coding	Explanation
B.1	Causal Condition: conditions that become the cause of the problem. (Many companies have already implemented and experienced the benefits from the implementation of the RL.
B.2	Central Phenomenon: the central phenomenon or main focus of this research. (Central phenomenon in this study is the level of maturity of implementation of the RL)
B.3	Consequences: the consequences that occur (consequence happened was that this framework will be able to change the pattern of thinking
B.4	Strategies: strategy being employed (In this phase, each company with detailed indicators and clear goals.
B.5	Context: situation which influences the actions (there are many methods that may minimize the budget)
B.6	Intervening Condition: inhibiting factor or factors that facilitate the occurrence of an event or behavior (action)

2.4.3 Data Analysis Phase

In this phase is expected to produce a new theory. The theory generated is a framework that serves as to measure the level of success of the implementation of the RL. Besides, this framework also helps companies improve the level of maturity of the implementation of the RL because the framework is equipped with 5 RL aspects and divided into 21 clear indicators.

2.4.4 Comparative Literature Phase

In this phase, the framework has been formed. The comparison with existing literature is necessary to know the advantages and drawbacks of the existing framework design. This phase is very important, especially for the future research. By comparing the framework that has been made with other research would allow further discussion in terms of the better design of the framework. This comparative literature is possible as might be because the limitation of information by previous researchers.

Table 2.4 Advantages and Drawbacks of Framework Design

Advantages	Drawbacks
1. Have a clear indicator for each stage or level. 2. Include whole perspective ranging from information technology, production planning, distribution, and business process and environmental. The determination of these perspectives was done by analyzing the perspective of RL research and it began in the 1980s to the present so that the category is very complete 3. Indicators employed easy language and instruction that is easy to learn and implement	Each indicator has not been completed with the process of how to achieve it. This is because the researchers assume that every company has a different strategy to achieve it. In addition to consideration that every company has some limitations, namely: ✓Modal ✓Human resources (skills) ✓Vision and mission

CHAPTER 3

THE FRAMEWORK AND INDICATORS

3.1 The Framework

The level division in "A Development of a Framework for Evaluation of Reverse Logistics Maturity Level" consists of 5 levels namely: Level 1: Conventional; Level 2: Managed; Level 3: Developed; Level 4: Innovative and Level 5: Optimized. Figure 3.1 below is the result of compiling the framework built with Grounded Theory approach.

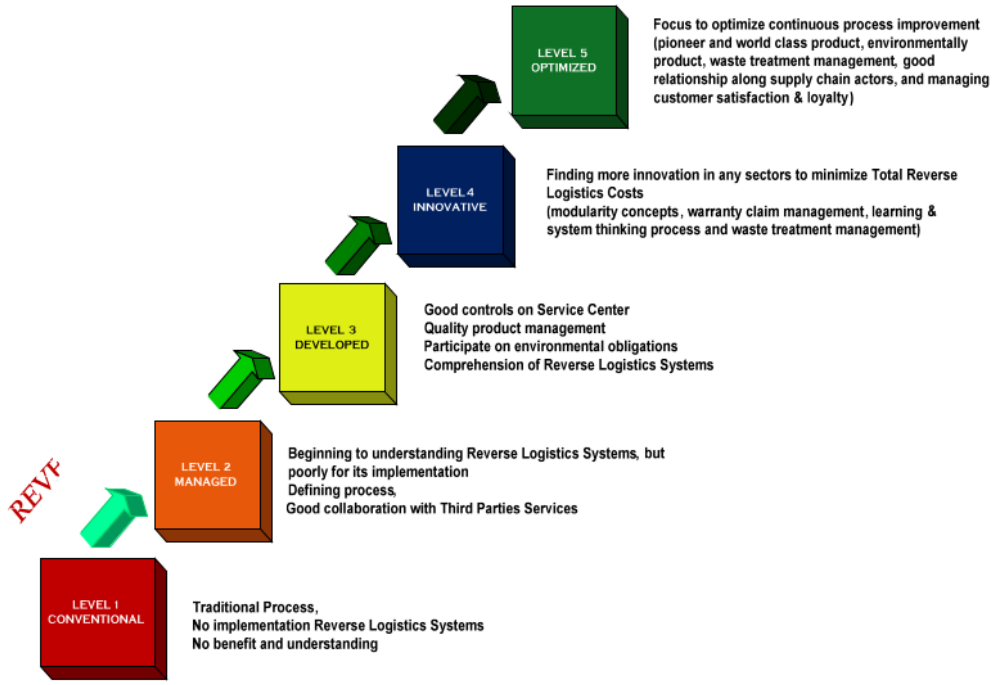

Figure 3.1 Reverse Logistics Maturity Level Framework

The following is the description of the above framework:

1. **Level 1-Conventional:** defines no implementation Reverse Logistics. The company usually uses traditional process to produce the product. They didn't understand the benefit if company implement the RL.

2. **Level 2-Managed**: is the second maturity level that company beginning to understanding Reverse Logistics benefit, but poorly for its implementation. Company tries to fulfill some environmental regulation even though not too much. Managing the customer claim, warranty process and repair service to maintain the customer satisfaction and loyalty. Even though company has a traditional waste treatment, they try to minimize the waste with accommodate secondary material to produce the product with good quality and specification.

3. **Level 3- Developed**: is a maturity level that characterizes company has comprehension toward Reverse Logistics concepts even though not too much.
   - Company has cooperation with third party services to take care customer complaint, services and warranty mechanism. Good product repair and service management.
   - Produce the environmental-friendly product and being introduce as a good quality product in the international community. Because company has standardized working systems and perform process control
   - Conduct the training system for employee to upgrade their system thinking and encourages a bigger and wider management
   - Waste treatment management to minimize waste and participate in environmental campaign

4. **Level 4- Innovative:** defines a maturity level where company finding more innovation in any sectors to minimize the total reverse logistics costs. Comprehension toward reverse logistics as well as the system thinking. Strong commitment from company to managing the customer complaint and increasing the satisfaction and loyalty of the customer. Produce the good quality product to fulfill the market needs. A good relationship with all stakeholders. Good management in collecting used product. A working system is standardization to

monitoring and improvement process. Secondary Treatment Process for waste and participate in environmental regulations.

5. **Level 5-Optimized**: is the final maturity level, where company focuses on optimizing continuous process improvement. Being a pioneer and world-class product, produce an environmentally product, good waste treatment mechanism, good relationship along reverse logistics actors systems and good management of customer satisfaction and loyalty.

In order to see to what extent the design of this maturity framework has clear standardization and must exist in every design of the maturity framework, then the comparison of some similar studies is made. For example the research that has been done by Kwak and Ibbs (2002); Kenny (2006); Constantinescu and Iacob (2007); Grim (2009); Tan et al (2011); Jochem et al (2011) and Dadhich and Chauhan (2012). The similarity of some researcher of the maturity above is:

1. Each maturity has clear level

   For example: Level 1, Level 2...and so on.
2. Each level has name that represents a certain level

   For example: *Conventional Level, Level Managed*
3. Clear information for each level
4. Each level has KPI (Key Performance Indicators)
5. Can be applied in the work process and have valuation function

In this chapter, we can also see the measurement of RL implementation in consumer electronics industry in Indonesia. Each level will be given an interval value of 1-5 to further facilitate the measurement. This measurement will be able to get an implementation illustration on consumer electronics industry group especially for a local company.

3.2 Indicator of Framework Maturity Reverse Logistics Level

The determination of assessment indicator in this framework is based on review literature that has been previously done. Some researchers argue that there are some things that must be done by the company in order to run the RL implementation well. deBrito et al (2002) argue that the successful key of RL implementation consists of RL Network Structures, RL Relationships, Inventory Management and Planning & Control of Recovery Activities. Other opinion presented by Pollock (2008), there are 10 keys to run RL well, namely:

1. Up to Date Support Offerings
2. Value-Added Services
3. Integrated Solutions
4. Effective Business Process
5. Empowerment and Accountability
6. Customer-Focused Front Line Organization
7. Flexible And Responsive Back-End Organization
8. State The Art Technology
9. Applying The Right Technology
10. Managing Continuous Change

Lau and Wang (2009) report that external factor such as public awareness, legislation, support of SC partners and internal factor consists of company policies, information and technological systems, personnel resources and others are some things that have to be met to support the RL implementation to run smoothly. While Ho et al (2012) argue that the indicators include company background, the degree of recognition and perception and internal & external factors. In addition, the final research by Deloitte (2014) states that optimizing forward logistics, synergies, product return policies, shorter product life cycles and consolidation of three flows

(financial, operational, information flow) are some things to consider in the RL implementation.

Based on many opinions of the experts either from practitioners and academics about the things that must be considered in the RL implementation in order to run well, then the research indicators in this framework are categorized into 5 aspects consisting of 21 assessment indicators. These 22 assessment indicators are obtained by previously spreading pre-sampling. From the pre-sampling that has been spread, there is 1 invalid assessment indicator namely the aspect of distribution for the C4 category namely Network. Thus, the number of assessment categories is 21. The following Table 3.1 is an indicator used for the measurement of the implementation of RL systems. In this Table, the Indicator is divided into 5 important parts namely Information Technology, Production Planning, Distribution, Business Process and Environmental. Furthermore, it will be outlined into several important sub-indicators.

Table 3.1 Indicator of RL System Implementation

No	Reverse Logistics Category	Assessment Categories
1	Reverse System Thinking and Information Management	1. The Comprehension of Reverse Logistics Concepts
		2. Benefit of Reverse Logistics Implementation
		3. The Reclaiming Product Management
2	Reverse Production and Operations Management	1. End of life Product Recovery and Inventory Management
		2. ICT/ Digital System Technology
		3. Quality Product
		4. Services Mechanism
3	Reverse Distribution	1. The Comprehensive of Relationship and Communication along Reverse Logistics Actors
		2. Collecting of Used Product Mechanism
		3. Locating Collection Center for Returned Used Product
4	Business Process	1.Leadership
		2.Strategic Planning

		3.Customer & Market Focused
		4.Measurement, Analysis & Knowledge Management
		5.Human Resources Focus
		6.Process Management
		7.Business Result
5	Reverse Sustainable Environmental	1. Waste Treatment Management
		2. Green Technology Application
		3. Participate on Environmental Legislation
		4. The Utilizing of Secondary Material

CHAPTER 4
CHARACTERISTIC OF FRAMEWORK

4.1 Characteristics of RL System Model

Here it will be explained some characteristics of the RL model that are divided into several levels according to the Framework Maturity of Reverse Logistics. This subchapter will discuss the second maturity level namely Managed Level. The Conventional level is not discussed because there is no RL implementation at all.

4.1.1 *Conventional Level*

In this level, the RL implementation is not carried out by the company at all. The process undertaken by the company is simple. Company management assumes that the company will not get the advantage and benefit by implementing RL in the company.

4.1.2 Managed Level

Managed Level is a Level that is one level higher than the Conventional Level. The illustration at this Level will be shown in Figure 4.1 below:

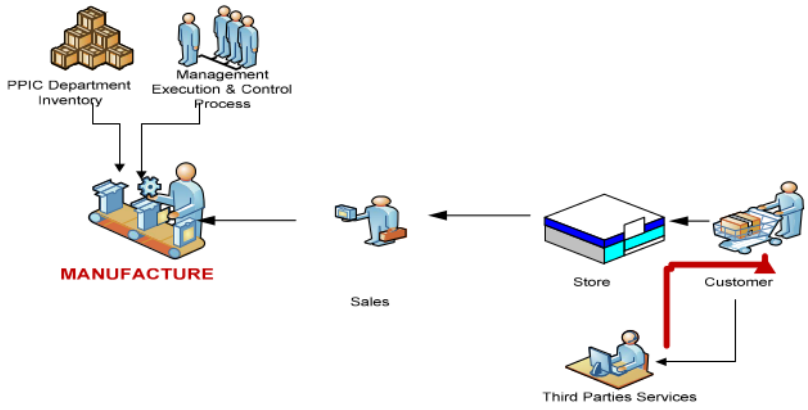

Figure 4.1 Illustration of RL Implementation of Managed Level

At this level, the company has little or no customer service. The existence of third parties services is very helpful in terms of product improvement. Here, the status of third parties services have no written cooperation with the company. Thus, only improvement process that can be done. Therefore, the issue of claim or maintenance of product warranty cannot be done. The claim or warranty can only be done at Distributor level or store. Furthermore, the product will be taken by the company for the improvement process. After the product is repaired, then the product will be returned to the company for the process of returning to the consumer.

The following is the activities performed by actors at the Managed Level, shown in Table 4.1 below:

Table 4.1 Actor and Activity at the Managed Level

No	Actor	Performed Activity
1	*Distributor/Retailer*	1. Ordering goods to the company according to market requirement
		2. Conducting sales process to the consumer directly
		3. Accepting claims or returns of products that is still within the warranty period for the improvement process
		4. Conducting the process of returning the product to the consumer after the goods have been repaired
2	*Manufacture (PPIC Department, Management, Marketing)*	1. Conducting the product improvement that is still within the warranty period
		2. Delivering the repaired product to the distribution center
		3. Receiving the product return from store and customer service for the improvement

4.1.3 Developed Level

The development of RL implementation at Developed Level has started to be complex. The company is already working with the third parties services to handle consumer issues and not rely solely on the company's authorized service center/station. The following is an illustration of the RL flow at the Developed Level shown in Figure 4.2.

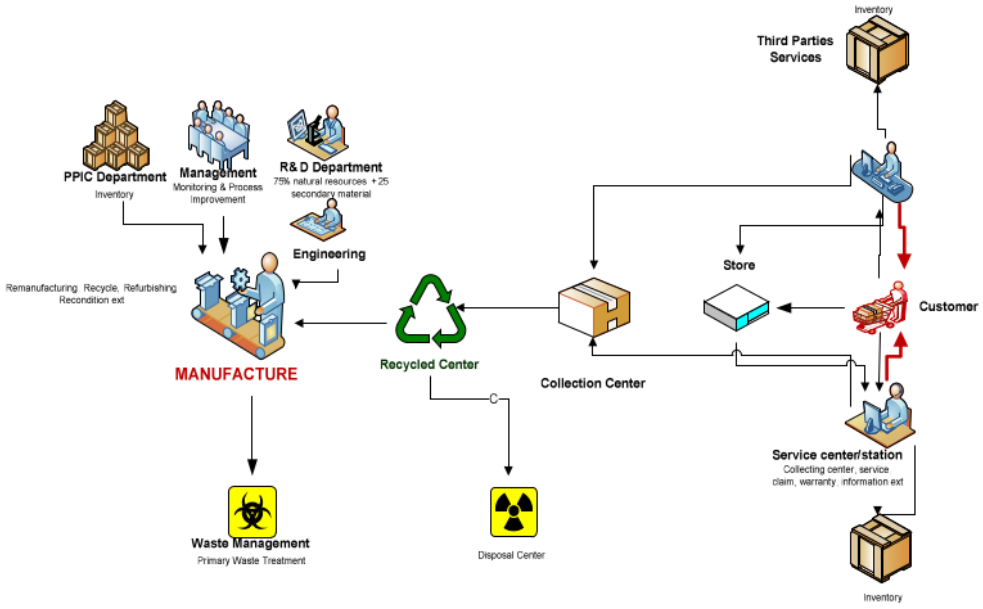

Figure 4.2 Illustration of RL Implementation of Developed Level

Figure 4.2 describes the actors in the Developed Level, the company's R&D Department should have a concept to design a simpler product because the product design should be able to adopt secondary material. In addition, the manufacturing process also takes into account aspect of products derived from natural resources and secondary materials. The duty of a service center/station is not only a service place for damaged products, claims, information but also as a place for collecting center. The details task of collecting center is to receive and identify products that cannot be used to be subsequently sent to the recycle center for disassembly product process, by processing part that can still be reused. The processes are remanufacturing, recycle,

refurbishing, recondition and so forth. The following Table 4.2 identifies the actors and activities undertaken by each actor in the Developed Level.

Table 4.2 Actor and Activity at the Developed Level

No	Actor	Performed Activity
1	Distributor Center, Retailer	1. Ordering goods to the company according to market requirement
		2. Conducting sales process to the consumer directly
		3. Accepting claims or returns of products that is still within the warranty period for the improvement process
		4. Conducting the process of returning the product to the consumer after the goods have been repaired
2	Third Parties Services	1. Serving product service from consumer → both product within the warranty period or not
		2. Conducting claim to the company for service products that is still within the warranty → service and part fee
		3. Ordering part to the company
		4. Conducting product return, for some improvement that cannot be handled by third parties services
3	Manufacture (PPIC Department, Management, R&D Department, Engineering)	1. Conducting production process in accordance with market demand → Marketing → PPIC Department
		2. Purchasing natural resources from suppliers → Purchasing
		3. Conducting the sorting process for secondary material that has been collected
		4. Through Engineering, R&D Department tries to design a product that matches quality, quantity, specification, durability by using secondary material
		5. Delivering finished goods to the whole seller according to demand
		6. Conducting Waste Treatment process precisely Primary Waste Treatment to manage waste production
		7. Serving part order either from service center or third parties services
		8. Receiving product return for some improvement that cannot be made in the service center or third parties

		services
4	Service Center	1. Serving product service from consumer → both product within the warranty period or not
		2. Conducting part order to the company
		3. Conducting product return, for some improvement that cannot be handled by the service center

4.1.4 Innovative Level

Figure 4.3 explains the flow of RL implementation at the Innovative Level in which the system has started to be complex from upstream to downstream.

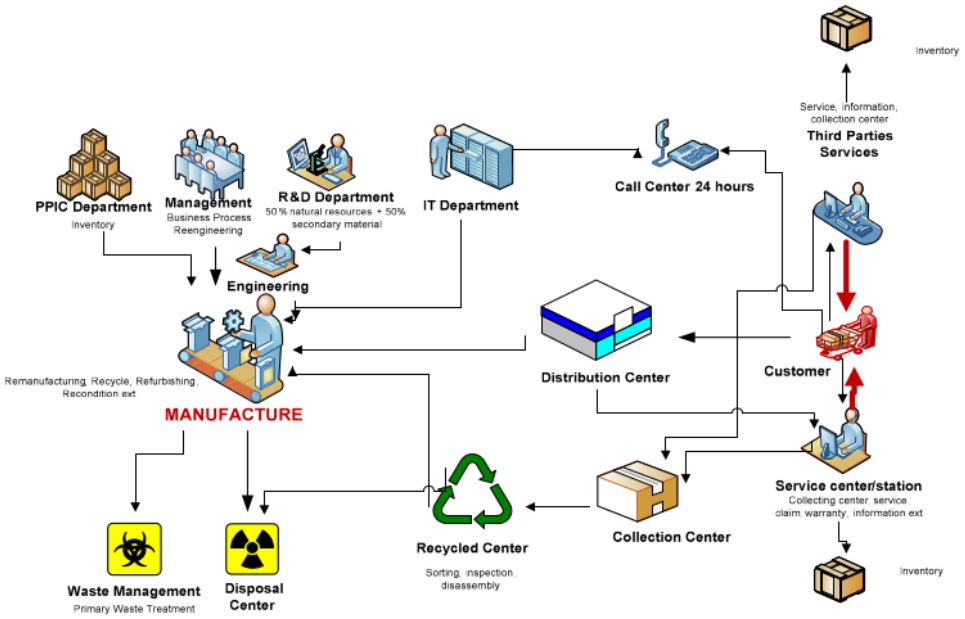

Figure 4.3 Illustration of RL Implementation of Innovative Level

At this level, the company is already integrated with the warehouse. The position of the warehouse is set up in such a way by the company, so its position is close to areas that have high market demand. The purpose of determining this warehouse is to make it easier for the company to distribute the products either to the whole seller, retailer or store. In addition, the store already has the double role as collection center that allows the consumer to get service. Besides, the IT Department

also has been integrated with Warehouse database that allows them in knowing the position of buffer stock from the Warehouse.

Table 4.3 Actor and Activity at the Innovative Level

No	Actor	Performed Activity
1	Distribution Center (Whole Seller, Retailer, Store)	1. Ordering goods to the company as needed
		2. Receiving damaged product and still have the warranty
2	Third Parties Services	1. Serving product service from consumer → both product within the warranty period or not
		2. Conducting a claim to the company for product service that is still within the warranty → service and part fee
		3. Ordering part to the company
		4. Conducting product return, for some improvement that cannot be handled by the service center
3	Manufacture (PPIC Department, Management, R&D Department, Engineering, IT Management)	1. Conducting production process in accordance with market demand → Marketing → PPIC Department
		2. Conducting the sorting process for secondary material that has been collected
		3. Through Engineering, R&D Department tries to design a product that matches quality, quantity, specification, durability by using secondary material
		4. Conducting Waste Treatment process precisely Secondary Waste Treatment to manage production waste
		5. Disposing products to Disposal Center for products/parts with categories that have not been able to process such as recycle, remanufacturing, refurbishing and others
		6. Serving part order either from service center or third parties services
		7. Receiving product return for some improvement that cannot be made in the service center or third

		parties services
		8. IT Department conducts synergistic monitoring system for 24-hour services and provides the information to the company
4	Service Center	1. Serving product service from consumer → both product within the warranty period or not
		2. Ordering part to the company
		3. Conducting product return, for some improvement that cannot be handled by the service center
		4. As a place for a collection center

Table 4.3 shows that the activities of actors at this Innovative Level have started to be complex. The company not only sells its products but also enhancing the customer loyalty and satisfaction that can still be improved and maintained.

4.1.5 Optimized Level

In the level of Maturity Level of RL, the Optimized Level is the highest level in this framework. In this level the company is required to work professionally and all systems. The IT Department's duty should always provide the latest information to every actor in the RL system. The integration of good information system will provide continuity of RL implementation. This is because every actor has done his/her role well. Figure 4.4 will describe the activity that occurs at this level.

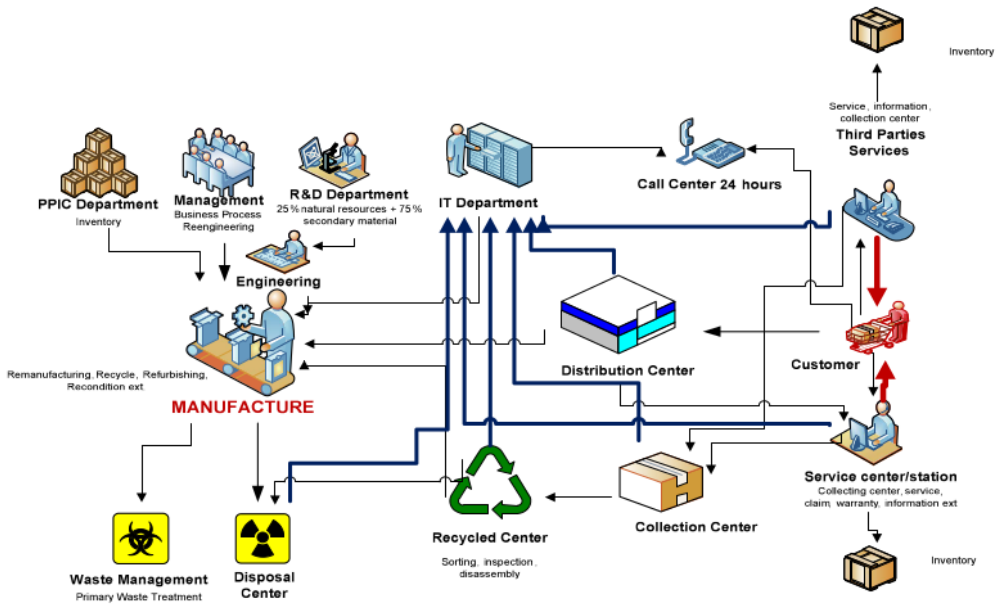

Figure 4.4 Illustration of RL Implementation of Optimized Level

The interesting thing on this level is the company gives flexibility to employees, especially the R&D Department to conduct research in the field of RL system and publish its research results internationally. Output to be achieved by the company is sharing information, suggestion, and idea both from practitioners and academics for the better the RL implementation of the company. Table 4.4 describes the activities of each actor at this very complex level.

Table 4.4 Actor and Activity at the Optimized Level

No	Actor	Performed Activity
1	Distribution Center (Whole Seller, Retailer, Store)	1. Ordering goods to the company as needed
		2. Receiving damaged product and still have the warranty
2	Third Party Services	1. Serving product service from consumer → both product within the warranty period or not
		2. Conducting a claim to the company for service product that is still within the warranty → service and part fee
		3. Ordering part to the company

		4. Conducting product return, for some improvement that cannot be handled by the service center
3	IT Department	1. Coordinating all departments ranging from PPIC Department, Management Party, R&D Department, Warehouse, Call Center, Collection Center to system buffer stock at Service Center and Third Parties Services
4	Manufacture (PPIC Department, Management, R&D Department, Engineering, IT Management)	1. Conducting production process in accordance with market demand → IT Department → Marketing → PPIC Department
		2. Conducting the sorting Process for secondary material that has been collected
		3. Through Engineering, R&D Department tries to design a product that matches quality, quantity, specification, durability by using secondary material
		4. Conducting Waste Treatment process precisely Secondary Waste Treatment to manage production waste
		5. Disposing products to Disposal Center for products / parts with categories that have not been able to process such as recycle, remanufacturing, refurbishing and others
		6. Serving part order either from service center or third parties services
		7. Receiving product return for some improvement that cannot be made in the service center or third parties services
5	Service Center	1. Serving product service from consumer → both product within the warranty period or not
		2. Conducting part order to the company
		3. Conducting product return, for some improvement that cannot be handled by the service center
		4. As a place for a collection center

CHAPTER 5
CASE STUDY: CONSUMER'S ELECTRONICS INDUSTRIES

5.1 Testing Framework Reverse Logistics Maturity Level

There are 3 consumer electronics companies used as research object to measure and assess the framework that has been prepared by the researcher. These companies are engaged in consumer electronics company such as TV making, Air Conditioning, Refrigerator, Video, Washing Machines, and Lamp. The data collected by the researcher comes from primary data in the form of filling questionnaire by the management company, direct interview and direct observation in the field. While the secondary data are obtained by accessing the information via the internet, data recaps from some service center/station and the data from the company itself.

The content of the questionnaire can be seen in detail in Appendix B. The following is an overview of the RL flow for the consumer of the electronics company.

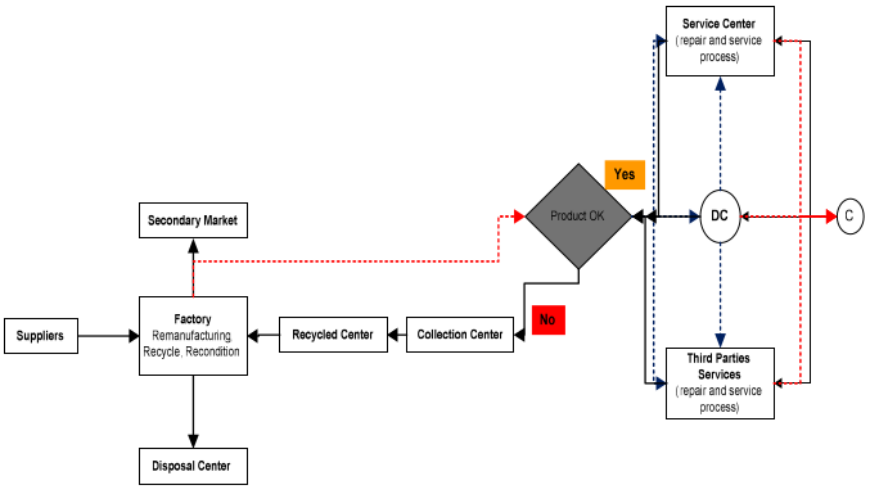

Figure 5.1 RL Flow for TV Products in general

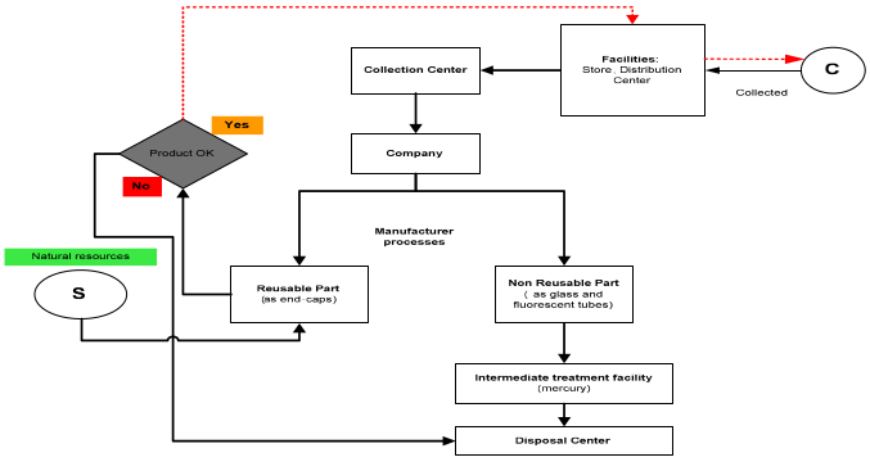

Figure 5.2 RL Flow for Lamp products in general

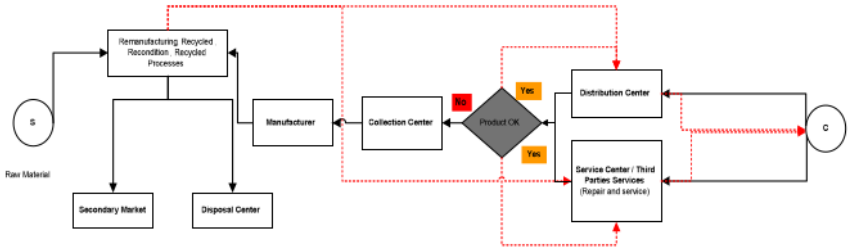

Figure 5.3 RL Flow for Video products in general

Figures 5.1, 5.2 and 5.3 are the RL flow for each of the company categories used as a case study and preliminary study to see how far the RL implementation in the consumer electronics industry group in Indonesia. These three flows are the RL implementation activity that have been done by the company. The next step is to fill in the questionnaire to determine the level of RL implementation in each company. The questionnaire is filled by people who are competent and understand about the RL implementation, production process and understand company policies and strategies. Table 5.1 is the data of questionnaire result that have been filled by 3 respondents from consumer electronics companies namely PT.PCB, PT.SA and PT.GMEI.

Table 5.1 Questionnaire Result

	R.L Categories	Indicators	P.C.B. Company	S.A. Company	G.M.E.I. Company
RL SISTEM ASPECTS	Reverse System Thinking and Information Management	A.1	1	1	1
		A.2	1	1	2
		A.3	2	1	1
	Reverse Production and Operations Management	B.1	2	1	2
		B.2	3	1	3
		B.3	2	1	3
		B.4	3	1	2
	Reverse Distribution	C.1	2	2	1
		C.2	3	1	2
		C.3	3	2	1
	Business Process	D.1	2	1	1
		D.2	3	1	2
		D.3	2	1	1
		D.4	2	2	2
		D.5	3	1	2
		D.6	3	2	2
		D.7	2	1	2
	Sustainable Environmental	E.1	2	2	1
		E.2	2	2	2
		E.3	2	1	2
		E.4	2	2	1

5.2 Statistical Test

In this sub-chapter, a statistical test will be conducted to find out the extent of the questionnaire result that has been distributed and collected. The statistical test is done as well as the validity and reliability test. Based on the results of Validity and Reliability Test, it can be concluded that this data is valid because r count > r table. With DF = N-2 with 95% of a confidence level or probability of 0.05 then it is obtained the value of r table with result of 0.4227. By looking at the column of Corrected Item-Total Correlation, it is obtained that the value is greater than r table, therefore the data obtained from PT. PCB, PT. SA and PT. GMEI is valid. However, to see if this data is said reliable then the value of Cronbach's Alpha must be > 0.6

(Tavakol and Dennick, 2011). From the column of Cronbach's Alpha Based on Standardized Item obtained the value of 0.891.

5.2.1 Transforming Ordinal Data to Interval Data with MSI (Method of Successive Interval)

MSI (Method of Successive Interval) or commonly called successive interval method is a method that functions to convert data that is ordinal into interval data. This is because the ordinal data is not actually quantitative data or real number. The questionnaire that has been distributed by using the Likert scale from scale 1 to 5. The results of the questionnaire are ordinal. In the development of this framework the number used as the symbol of qualitative data is as follows:

1. Number 1 represents "Not implemented"
2. Number 2 represents "Not implemented but there is already a discourse there"
3. Number 3 represents "Already implemented but still simple"
4. Number 4 represents "Already implemented with wider implementation area"
5. Number 5 represents "Implemented well"

The steps in the MSI are divided into 7 parts, among others:

1. Calculating Frequency

   Calculating the number of query results obtained
2. Calculating Proportion (P)

   The proportion is calculated by dividing each frequency by the number of respondents.
3. Calculating Cumulative Proportion (PK)

   The cumulative proportion is calculated by summing the proportion in sequence for each value.
4. Finding Z Value

   The z value is obtained from the standard normal distribution table (*critical value of z*). With the assumption that the cumulative proportion is distributed

standard normal. If the value cannot be obtained from the table, it will be interpolated to get the value in question.

5. Calculating Density F (z)

   The value of F (z) is obtained by calculating using the following formula:

$$F(z) = \frac{1}{\sqrt{2\pi}} Exp\left(-\frac{1}{2}Z^2\right) \qquad (4.1)$$

6. Calculating *Scale Value*

   The formula used to calculate Scale Value is:

$$Sv = \frac{Density\ at\ Lower\ Limit - Density\ at\ Upper\ Limit}{Area\ Under\ Upper\ Limit - Area\ Under\ Lower\ Limit} \qquad (4.2)$$

$$Note = \frac{Density\ Value = value\ taken\ from\ Density\ z}{Area = value\ taken\ from\ Cumulative\ Proportion} \qquad (4.3)$$

7. Calculating the scaling value

   From the calculation of frequency up to Scale Value (Sv) then the last step is to calculate the scaling value.

The transformation of ordinal data to the interval that has been done from step 1 to 7 can be summarized in the following table 5.2.5.3 and 5.4. In the same way, it is obtained the result of ordinal data transformation to the interval for PT. SA and PT. GMEI.

Table 5.2 Result of Ordinal Data Transformation to the Interval of PT. PCB

ORDINAL SCORING SCALE	FREQUENCY	PROPORTION	CUMMULATIVE PROPORTION	Z SCALE	DENSITY F(z)	SCALE VALUE (Sv)	VALUE OF SCALLING
1	2	0.0952	0.0952	-1.3074	0.1698	-1.7825	1.0000
2	12	0.5714	0.6667	0.4311	0.3636	-0.3393	2.4432
3	7	0.3333	1.0000	0.0000	0.0000	1.0909	3.8734
4	0	0.0000	1.0000	0.0000	0.0000	0.0000	2.7825
5	0	0.0000	1.0000	0.0000	0.0000	0.0000	2.7825
Σ	21					MEAN	2.5763

Table 5.3 Result of Ordinal Data Transformation to the Interval of PT. SA

ORDINAL SCORING SCALE	FREQUENCY	PROPORTION	CUMMULATIVE PROPORTION	Z SCALE	DENSITY F(z)	SCALE VALUE (Sv)	VALUE OF SCALLING
1	14	0.6667	0.6667	0.0597	0.3983	-0.5975	1.0000
2	7	0.3333	1.0000	0.0000	0.3990	-0.0021	1.5954
3	0	0.0000	1.0000	0.0000	0.0000	0.0000	1.5975
4	0	0.0000	1.0000	0.0000	0.0000	0.0000	1.5975
5	0	0.0000	1.0000	0.0000	0.0000	0.0000	1.5975
Σ	21					MEAN	1.4776

Table 5.4 Result of Ordinal Data Transformation to the Interval of PT. GMEI

ORDINAL SCORING SCALE	FREQUENCY	PROPORTION	CUMMULATIVE PROPORTION	Z SCALE	DENSITY F(z)	SCALE VALUE (Sv)	VALUE OF SCALLING
1	8	0.3810	0.3810	-0.3029	0.3812	-1.0005	1.0000
2	11	0.5238	0.9048	1.3074	0.1698	0.4036	2.4041
3	2	0.0952	1.0000	0.0000	0.0000	0.0000	2.0005
4	0	0.0000	1.0000	0.0000	0.0000	0.0000	2.0005
5	0	0.0000	1.0000	0.0000	0.0000	0.0000	2.0005
Σ	21					MEAN	1.8811

With the interval value of the specified framework, the value of the ordinal data transformation to the interval is as follows:

1. Value between 0 – 1 = Conventional Level
2. Value between 1 – 2 = Managed Level
3. Value between 2 – 3 = Developed Level
4. Value between 3 - 4 = Innovative Level
5. Value between 4 – 5 = Optimized Level

Table 4.16, 4.17 and 4.18 show the results of the interval value of PT. PCB, PT. SA and PT. GMEI with the MSI method are 2.5763, 1.4776 and 1.8811 respectively. PT. PCB is at the Developed Level, while PT. SA and PT. GMEI are at the Managed Level.

CHAPTER 6
DISCUSSION

The design results of Framework Maturity of Reverse Logistics implemented in the consumer electronics industry have similarity to the maturity framework conducted by Garcia (2008), Battista et al. (2011) and Oliveira et al. (2011). All frameworks are divided into 5 different levels. However, this framework is different from Mendes et al. (2016). The difference lies in the determination of assessment categories to measure the level of maturity. In the research by Mendes et al. (2016), the identification of its category is derived from research that has been done by Lambert (2008). Meanwhile in this research, the category is derived from success claim conducted by the company on the RL implementation. The claim is in the form of profit generated by the company, the reduction of used material, and minimization of generated waste.

This framework is developed by using the GT method. The level of maturity is divided into five levels. The five levels are Conventional Level, Managed, Developed, Innovative and Optimized. Here are the criteria for each level, namely:

A. Conventional Level

Conventional level is the lowest level in the RL level of maturity level. The company that includes in this Conventional Level has the following characteristics:

1. There is no RL system implementation
2. There is absolutely no understanding of the benefits to be gained from this implementation. The benefits that can be obtained such as energy saving, as well as the reduction in mining waste and water emission. Besides, other benefits that can be obtained are asset utilization, recovery, customer satisfaction & loyalty, and the most important is the fulfillment of environment obligations.

3. The company always uses natural resources in every production process and the product design

For the type of company included in this Level, there needs to be an effort of understanding and education from related parties to change way of thinking. The policy can be the second alternative so that company is willing to implement the RL. In this case, there are 2 types of policies namely governmental policy and company's policy. The government as the regulator and facilitator must support every company that will lead to the better direction for the sake of the conservation of mankind and the environment.

B. Managed Level

This level is one level higher than the previous Conventional Level. The characteristics of the company that implements the RL system at this Level are:

1. Very narrow understanding of the concepts, mechanisms, controls, and implementation of the RL system. However, in reality, the company has implemented the RL system even though it has not been in accordance with the correct RL method.
2. There is still no effort and high awareness of the company management to implement the integrated RL system
3. There is educational and learning process that continues to grow and develop in the company's management system
4. There is already warranty problem perspective and product claim that are damaged or not according to specification

At this stage, the understanding of RL concept already exists even though its nature is still very simple, but the company has the high commitment to learn the benefits that can be taken from this system. Besides, this level indicates that the company already has illustration/perspective about the problem of product warranty given to the consumer as well as the claimed problem. The product warranty issues

and the claim require serious attention from the company because it will impact on the issue of costs to be incurred by the company. The reason is because damage case is still the responsibility of the company.

C. Developed Level

Developed Level is a Level that already feels the significant benefits of RL implementation. The company which includes this Level has the following characteristics:

1. The company has implemented the RL system and has obtained some benefits
2. There are good management and control system for all actors involved in the process of returning a product from the consumer as the end user to the service center/station
3. The company has established a network and communication with the third parties outside the company's management in terms of service process or claim from the consumer
4. The company has paid attention to the aspects of energy saving, green product, and eco-efficiency in the product development.

The advantage of the company with this Level is the company already has cooperation with the third party for the problem of product improvement and claim coming from the company. The company does not have to establish many service center/station because there are the third parties who can help with SOP (Standard Operational Procedure) provided by the company to maintain the quality of the product itself. The SOP includes:

a) Improvement procedure/service must be in accordance with the procedure of the company

b) Using parts or component that is compatible with the original component, which are manufactured and issued by the company

c) Using adequate equipment in order not to damage the quality and quantity of the product itself

d) Service system for warranty process, claims, and other damages either part of the company's responsibility or not, should be in accordance with the applicable provision

D. Innovative Level

At this stage, the company has started to grow into an adult company because the wide coverage of the RL implementation. The company includes in this Level has the following characteristics:

1. The scope of the RL system is expanded from upstream to downstream. The role of supplier, whole seller, retailer, service center/station, until the company itself is well integrated through networking and information flow among several related parties
2. Attention to product warranty case is constantly improved and becomes the concern of the company. The product warranty is a guaranteed process from the company that a product should have appropriate quality and quantity. Because it is closely related to the problem of cost and customer satisfaction and loyalty
3. The environmental problem also begins to be the concern to this Level. The limitation of a number of raw material from natural resources and the problem of waste from the production process becomes one of the strong reasons for the company to redesign its products to be more environmentally friendly and does not cause waste that damages the environment.
4. Participating in the success of government policy for environmental sustainability. In addition, the company also has its own policy to maintain

and improve the environment due to the natural resources used as the material of a product

E. Optimized Level

The company that has successfully implemented the Optimized Level in its company is a world-class company. The competence has been recognized by the world both in terms of product quality, management and policy that have been made. The characteristics of the company include in this Level are:

1. Trying to create a strategy to reduce costs incurred due to product warranty process. The product within the warranty period is the company's responsibility to replace, repair the product in case of damage
2. There is a well-integrated system for product warranty claims issues. Starting from the availability of service center/station with widespread existence, call service, claims management, up to the service provided by the company in order to provide satisfaction to the consumer
3. Very concerned about environmental issues, both the use of secondary material to suppress the rate of the use of natural resources up to waste problem either from the production process or after the life/use period. Besides, it also supports the regulations internationally, regionally and domestically in the framework of environmental sustainability
4. Always innovating to reduce the amount of waste in the production floor
5. A management system with a recognized success ranging from the leadership process; strategic planning; customer & market focus; measurement, analysis & knowledge management, human resources focus, process management and business result.

Based on the results of the calculation of MSI as shown in Table 5.2, 5.3 and 5.4, it is obtained the following results: PT. PCB obtains a result of 2.5763 which

means supporting the Developed Level. While PT. SA and PT. GMEI each result is 1.4776 and 1.8811. Both companies support the Managed Level. Here are the characteristics of companies that support the Developed Level seen from each assessment indicator those are:

1) The aspect of Reverse System Thinking and Information Management

   Collaboration with the third parties is well established. The company continues to conduct educational systems both at the decision-making level and middle management on the benefits of RL implementation and how the RL system can be applied well to the company.

2) The aspect of Reverse Production and Operations Management

   There is a balance between production and market demand, thus no over stock. The company has been trying to make products with very simple design to facilitate the improvement process, however the quality of produced product remains high. Besides that, the improvement on the service center does not go beyond the date of agreement with the consumer. This is to avoid dissatisfaction from the consumer.

3) The aspect of Reverse Distribution

   The layout of the existence of service center or third parties services at least 2 service centers for each city. This is to facilitate the mechanism of product return from the consumer or along the reverse logistics actor. It takes continuous and up to date information along the RL actor to facilitate communication and data information.

4) The aspect of Business Process

   The company tries to be superior company although it is still within the region. It commits to create high-class and high-quality products. The well-integrated management system is well maintained.

5) The aspect of Sustainable Environmental

The company already has primary treatment for its waste treatment process. The Company has committed to participate in environmental issues. In addition, the company has implemented simple modularity concept. This is to facilitate the problem of the production process and the use of the secondary material.

While the company that is at Level 2 or Managed has the following characteristics:

1) Aspect of information technology

   The thinking paradigm of the company about the RL concept is still very general. Information about RL is very difficult to obtain, RL GDSS (Group Discussion Support System) is still rare. Thus, the discourse, benefits and the latest information of RL are very difficult to obtain. Between the benefits that will be perceived by the company with the costs incurred in accordance with the RL concept will not be comparable.

2) Aspect of production planning

   The inventory management system is still very simple so as to allow imbalance between demand and supply because the part often experiences delays. The company begins to direct its products based on digital/ICT so that it is more environmentally friendly and energy efficient. While the product has medium quality

3) Aspect of distribution

   The company has already simple distribution facility that covers collection center, recycled center and distributor. In this case, the retailer is to facilitate forward and reverse in order to run well. There is only one official service center owned by the company in one city.

4) Aspect of business process

The company already has vision and mission for the company development. Starting from product development, product sales, employee training. But all of these concepts are to encourage the creation of products made from virgin material rather than the utilization of secondary material and waste resulting from the production process or after the product is out of service.

5) Aspect of environmental

Waste treatment system which is still simple. The waste management has been implemented by the company in every line of the company.

CHAPTER 7
CONCLUSION

Recently, the increasingly worrisome environmental problem is starting to get the world's attention. Global warming, climate change, waste, and the limitation of natural resources encourage people to always think innovatively in solving these problems. The number of regulations issued internationally, regionally and locally, aims to preserve the environment for the livelihood of many people.

In order to solve these problems, Reverse Logistics (RL) system is used to minimize the amount of waste by utilizing the secondary material in the process making of the product. It needs thorough cooperation of all actors along the RL track so that the system can run smoothly. The actors include: Consumer as end users, Distribution Centers (Wholesaler, Distributors, Retailers), Service Centers, 3rd Parties Services, Collection Centers, Recycled Centers, Disposal Centers and the company as the spearhead in doing recycle process, remanufacturing, refurbish, and recondition. In addition, the role of government as regulator and facility provider must provide support for the RL implementation. The government not only produces rules that force the company to create energy saving and environmentally friendly products, use nanotechnology and low-cost, but it provides a lot of training, comparative study, knowledge transfer to the company for better future.

7.1 Conclusion of Research Result

The research of RL model design in this consumer electronics industry can be drawn into three conclusions based on the testing process those are:

1. The RL implementation that occurs in three consumer electronics companies, especially the local company occupies level 3 (Managed Level) and 2 (Managed Level). At this level, the company is still in the learning stage of the RL concept as a whole which includes benefits, availability of human

resources, capital, change of thinking concept until technological change and material use. Basically, the company at this level is already applying in a very simple way. In the company's strategy, the RL concept is not well understood. The value obtained by using the MSI method is successively from PT. PCB, PT. SA and PT. GMEI is 2.5763, 1.4776 and 1.8811. This framework can be applied to other industry clusters such as paper industry, computer industry that has the largest amount of return.

2. Estimation of Total Reverse Logistics Costs (TRLC) aims to help the company to know the estimated costs to be incurred based on the number of actors and the complexity of a combined system. Entering the attribute of Third Parties Services (TPS) has a significant impact because of the damage PT. PCB warranty product returned to the service center is overwhelming. This causes the cost incurred by the company is very large because the company bears the cost entirely. Based on Solver Status that has reached the Global Solution as obtained result of IDR 20,433,500.- at iteration of 10,529. The cost components consist of 52% of Total Transportation Costs, 36% of Total Holding Costs and 12% from others.
3. The development of HRL is the third conclusion in which its benefit is to know to what extent the level of consumer's satisfaction, perception, and expectation. Based on voice of customer and technical response, there are several steps that must be taken by the company, among others: 3PL integration and mechanism (0.20), Establish and collaborate the Reverse Logistics support system (collection center, recycle center, disposal center) (0.11), Standardization of service mechanism (0.10), Technology supporting (0.07), and Design the integrated management information system along supply chain actors (0.07).

7.2 Research Contribution

This research has a contribution which is divided into two aspects, namely current knowledge and practical implication.

7.2.1 Current knowledge

In this research, the gap is formed based on literature study about RL conducted on journals from Science Direct, Emerald, ProQuest, IEEE, Hindawi, Inderscience and Francis & Taylor. The renewal in the field of science is as follows:

1. The number of companies that claim the success of RL implementation but there is no indicator or parameter that governs it. In Framework Reverse Logistics Maturity Level design, each level is given clear indicator and parameter ranging from Level of Conventional, Managed, Developed, Innovative and Optimized so that it is easy to learn and implement.
2. It is TRLC cost estimation calculation that is able to analyze all costs that must be borne by the company due to the occurrence of product return which is the responsibility of the company to repair it during the warranty period. With the addition of the 3rd Parties Services attribute allows the greater complexity of the RL system.
3. It is a new approach to know the hope and expectation of consumer especially for RL issue that includes RL Input, RL Structure, RL Process, RL Output and RL Social & Organization Aspect.

7.2.2 Practical Implication

In addition to contribute to the science, this research also contributes directly to the RL actors who participate in implementing it.

1. Providing an overview of the success rate of RL implementation that has been applied especially to the consumer electronics industry. This success rate will

be measured at several levels. Thus, the company will know and understand the level of RL implementation that has been done so far.

2. The company knows the total cost that must be incurred if the company will implement the RL system or increase its level.
3. Knowing the needs and desires of the consumer. By knowing the desire of the consumer, they will be able to minimize the number of complaints that occur to maintain the customer satisfaction.
4. By knowing the type of damage that occurs, the company through its product innovation will be able to design the product in such a way so that the type of part that is often damaged can be mass produced. This will provide great benefits for the company according to the modularity concept.
5. Knowing more about the character of the consumer, especially Indonesian consumer, before marketing its products based on educational background, financial, social economy, available facility and other habits.
6. Consumer will get more educational opportunity/learning from the product marketing before buying the product. Thus, the consumer already knows what should be done when using the product or if there is damage.

7.3 Limitation of Research

This research has limitation due to several things, among others, are the assumption and parameter used. In the reverse logistics model design, the framework development is divided into 5 levels consisting of five process areas and 21 assessment categories. Subsequent research allows the addition of assessment categories so that the parameter is more detailed. This can be improved if a better new parameter or assessment categories to measure the success rate of RL can be found in the future. While for TRLC calculation, the more complex the RL system used and the number of actors involved, the greater the cost calculation. The process of developing HRL is done by adopting the QFD method. This HRL is developed

based on the research conducted by deBrito et al., (2002) by adding 1 perspective namely Organization and Social. This perspective will be able to grow again if the coverage area of RL research develops more broadly. The more precise the strategy used by the company, to know the needs and desires of the consumer, then the more the sustainability of a company can be maintained.

7.4 Advanced Research

RL model design research on the consumer electronics industry, there are still many advanced research opportunities, among others:

1. If the RL design is implemented in the industrial sector other than electronics consumption, then the process area divided into 21 assessment categories, will it still able to be used to measure the success rate of RL. Therefore, it needs to study the flexibility of process area and assessment categories.
2. It is required correlation analysis study of the relation between the regulations with the RL implementation. This will be a knowledge-based research that examines the impact of the regulation issued by the government on the RL implementation conducted by the company. This is because there are still many overlapping regulations between one departments with other departments. The method that can be used is agent-based modeling.

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APPENDIX

Process Area	No	Assessment Categories	Reverse Logistics (RL) Maturity Index				
			Level 1 Conventional	Level 2 Managed	Level 3 Develop	Level 4 Innovative	Level 5 Optimized
Reverse System Thinking and Information Management	1	The Comprehension of Reverse Logistics Concepts	No understanding towards reverse logistics concepts	Very limited understanding towards reverse logistics concepts; information is obtained from reading, newspapers, magazines or the internet	Comprehension towards reverse logistics concepts even though not too much	Comprehension towards reverse logistics concepts as well as the thinking system of reverse logistics systems	Comprehension towards reverse logistics concepts, starting from its thinking system, the framework, until the benefit of the implementation of reverse logistics systems
	2	Benefit of Reverse Logistics Implementation	No benefit for implementation of reverse logistics systems	Comprehension of reverse logistics concepts even though not too much	Company getting benefit from implementation of reverse logistics systems from the use of secondary material in production	Getting benefit of remanufacturing, recycle and recondition processes	Obtain a lot of benefits from remanufacturing, recycling, reconditioning, energy savings, using secondary material, reducing mining wastes, ter emission, capital as well as increasing customer satisfaction and loyalty
	3	The Reclaiming Product Management	No servicing services from company	Understanding towards the concept of thinking system about customer's complaint	The Company has cooperation with the third party services to take care of customer's complaint claim and product warranty	The company has many service centers/ stations and strong commitment to overcome customer's problem	Company's service center/station gives100% product warranty and give the best services to maintain customer satisfaction & loyalty
Reverse Production and Operations Management	1	End of life Product Recovery and Inventory Systems	The company has not integrated PPIC management system	Traditional PPIC management systems	There is a balance between demand and production process requirements	The company produces spare parts/ products that meet market demand and fulfill the inventory systems	No overproduction/zero inventory because the company's production relies solely upon market demand
	2	ICT/Digital Systems Technology	The company does not produce a product integrating ICT/digital product principle	Electronic products will be developed based on ICT / digital principles and to fulfill environmental obligations	The development of consumer electronics products is based on digital/ICT and the products are environmentally friendly/green and energy efficient	Electronics products are digital/ICT-based, eco-friendly / green and energy efficient. They are developed using the nanotechnology	Electronics products, medical devices and control equipment as well as electronic components are developed using nanotechnology. The products become the pioneer in the market.

	3	Quality Product	Produce poor-quality product	Produce mild-quality product	Produce high quality product being produced with high technology	Produce high-quality, high-quantity, high specification and durable products	Produce high quality products that are able to compete with imported products
	4	Services Mechanism	Repair service takes too much time or longer than due date informed to customers	Repair service is using conventional method and, as the consequence, it takes too much time or longer than due date	There is a time management being set so that repair service does not take longer than the due date	The company is able to finish repairing defected products on the due date	The company is able to finish repairing defected products on the due date and notifies customers that their defected products have been repaired
Reverse Distribution	1	The Comprehensive of Relationship and Communication along Reverse Logistics Actors	No communication systems or the communication systems between actors reverse logistics use the simplest, most convenient means of communication e.g. telephone	The relationship among actors of reverse logistics is developed using a better system and various means of communication e.g. telephone, email and IT devices	an integrated management information system has been established so that the reverse logistics actors can always monitor the progress and provide the most current information	Needs and company information can be accessed publicly by the actors reverse logistics systems,; such condition develops stable condition	Sophisticated Management Information Systems with updated information can be accessed 24 hours. There is gathering between the company with reverse logistics actors continuously
	2	Collecting of Used Product Mechanism	No collecting product by company	The company prepares facilities for collecting their damaged product, under warranty or older products	The company has a simple facility for collecting the damaged products	The company has a collection center/station for collecting product from the customer as the end user, warehouse, store and ext	The company has many collection centers of which location is based on customer's highest demand and has relationship with the third party services
	3	Locating Collection Center for Returned Used Product	No service center/station	There is only one service center/station in each big city	The company has >2 service center/ station in each city	The company has an affiliation with the third party services (store)	Good networking and integrated system with update information from the service center/station and they are easy to find (more than 1 service center per city)
Business Process	1	Leadership	No responsibility for company	The company started to build paradox capability management by recognizing the existence of a wide range of alternative views	The company encourages a bigger and wider management where people, ideas, resources, processes, markets and other important factors considered in a comprehensive way, not only partially	The company has already had the ability to recognize the diversity of individuals in the team who have different backgrounds	There is an opportunity to change, due to the urgent needs that allows the acceptance of ambiguity and risk in a global context. There is transparent organization and companies can receive and learn new things. The company must have the ability to read global market opportunities, has access to

							global information, and is capable of being a threat to competitors. The company should also be able to use resources from around the world in any competitive situation.
	2	Strategic Planning	The products is sold by the company only to meet the market demand	The company has a desire to expand overseas sales	The products is known by the international community especially across Asia	With the ISO Certification and other certifications, the products starts to be known not only in Asia but also worldwide	The product was a pioneer, and gain certification of product quality
	3	Customer & Market Focus	The company only sells products but does not have any customer service to accommodate all kinds of grievances or complaints from consumers	The company has already had a customer service to accommodate all the complaints, and suggestions from consumers	Not only have does it have a customer service/station, but the company also has already had a strategy to improve customer satisfaction	The company has already had 24-hour online IT facilities to accommodate all consumer's needs	The company has a strategy in every product being produced to meet the characteristics of consumers e.g. price, product specifications, product complexity and customer behavior to increase customer satisfaction and loyalty
	4	Measurement, Analysis	There is no system of education to the employees about the importance of reverse logistics systems	Gradually, the company gives the reverse logistics material for training	The Company conducts training about basic concept of the reverse logistics system in the production process	Periodically, the company conducts training the latest issues in the reverse logistics to employees	The company facilitates employees to conduct and publish their research about reverse logistics or talk in seminar for great benefits of the company
	5	Human Resources Focus	The production process runs according to office hours, employees are paid a salary in accordance with the amount of work they have done	Companies give rewards to employees who have high performance	The company has a standardized working system for example standardized time, the time cycle for each production. In addition, there is training to introduce new methods especially reverse logistics systems	Working system is standardized. A lot of the learning processes are conducted to enhance production performance, a good payroll system with a variety of benefits or rewards	A variety of working systems, a lot of the learning process to enhance production performance, a good payroll system with a variety of benefits or rewards. The company provides retirement money for the welfare of its employees
	6	Process Management	In this phase, the company has a traditional management process. The purposes of the company are mainly profit and	**19 fining Process.** In this phase, the process's owner will design, analyze and define business	**Execute and perform process control.** The results of the modeling and design process are undertaken by	**Monitoring and Improvement Process.** Business processes that have been implemented monitor the performance by	**Business Process Innovation** This process represents the highest level; at this stage the company must understand the soul of the business process.

			minimizing total costs. It neglects the management process to get better condition	processes that will be automated starting from workflow activities, information flow, business rules and policies, required resources and the performance calculation (Key Performance Indicators)	the manager and then forwarded to IT for automation. After the implementation, employees and related parties will carry out the process in accordance to the rules that have been established previously as well as supervisors and on-duty managers to control the process	calculating Key Performance Indicators. System monitoring is conducting by using the data in real-time so the finding is in accordance with the real situation in the field. From the results of such monitoring, the management can see and analyze whether the necessary repairs to a business process are necessary or not. Eliminating delays in business processes because delay is essentially a waste. At this stage, the company is implementing Business Process Reengineering that is an activity by reducing the time from another activity to make improvements at a more advanced level e.g. find double work etc.	Business Process Innovation activities are based on the orientation of the goal in the background or why they are carried out. The design of a new process to fully utilize the technology remains the main goal
	7	Business Result	Firms produce goods according to market needs	The company manufactures products according to market needs but also pays attention to the characteristics of Indonesian consumers	In addition to producing products that meet with the character of Indonesian consumers, the company produce products with good design to ease recycling them	The resulting product has led to a green product which is the social responsibility of companies. As an addition, the company also runs CSR (Corporate Social Responsibility) program	Environmentally friendly products, easy to recycle, and CSR are not just the responsibility of the company but also the social organization e.g. helping natural disaster victims.
Reverse Sustainable Environmental	1	Waste Treatment Management	Company does not has a waste water treatment system	The company has a traditional waste water treatment system	**Primary Treatment** The company has already had a waste treatment system i.e. level 1/Primary Treatment or wastewater treatment system that ensures that hazardous substances used in the	**Secondary Treatment** Companies have Level 2 (Secondary Treatment) waste water system that aims at eliminating biological contamination from wastewater through aeration process by	**Advanced Waste Treatment** The Company has the Advanced Waste Treatment to ensure that there are no sources of pollution such as disease-causing agents, chemicals that dissolve in water-organic, fertilizers,

					production process has been treated so it is safe for the environment	developing bacteria or other biological organisms. Apart from these two processes, secondary treatment is also equipped with a sludge handling system resulting in digestion, dewatering and disposal of solid.	organic chemicals, sediment or suspension materials, radioactive materials, and heat
	2	Green Technology Application	There is still a lot of waste that spilled on the floor of the factory	Waste Management has started to be applied to all production processes	The company has already implemented various methods or approaches for reducing waste	The company has already had a good waste management	The company is strongly committed to a zero defect or zero waste in the production process
	3	Participate on Environmental Legislation	The company does not have any contribute to the design of environmental legislations	The company contributes to the environmental legislation though a small one. It obeys the policy that has been issued by the government	Participates in environmental campaign and supports the government programs	Provides creative ideas, suggestions and innovations in the design and development of policy issues related to environmental sustainability	Being a pioneer in environmental sustainability policy issues and is responsible so that its products does not cause any damage to the environment
	4	The Utilizing of Secondary Material	The company uses 100% of natural materials / resources in production process	The company uses 90% of natural material and 10% of secondary material	The company uses 75% of natural material and 25% of secondary material	The company uses 50% of natural material and 50% of secondary material	The company uses 75% or more of secondary material and is committed to the preservation of natural resources and the environment

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