12. Total Reverse Logistics Costs: The Analysis of Cost Drivers to Successful Implementation of Reverse Logistics

By Farida Pulansari

Total Reverse Logistics Costs: The Analysis of Cost Drivers to Successful Implementation of Reverse Logistics

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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 proposes how to minimize of the Total Reverse Logistics Costs (TRLC) by considering the reverse cost drivers. TRLC is influenced by some drivers, such as customer as end users, third parties services, service center, collection center, recycled center, manufacturer and disposal center. The result shows TRLC is influenced by 52% from total transportation costs, 36% from total holding costs and 12% from other factor.

Keywords: Reverse logistics, Costs, Third Parties Services, Electronic Industry Consumption

1. Introduction

The limitation of natural resources has encouraged companies to implement particular policies [1], namely policies related to legislation, social responsibility, corporate imaging, environmental concerns, economic benefits, and customer awareness. These efforts are to produce green product, energy savings, minimizing waste, and better policies concerning with environmentally friendly.

There are several techniques that have been developed to overcome these issues. RL is one of methods to solve some environmental problems. Lambert et al. [2] and Bai and Sarkis [3] reported that studies related to RL showed that it is more capable and flexible of covering the problems from the pr actical working to the environment. A recent study conducted by Nikolaou et al. [4] proposed a Corporate Social Responsibility (CSR) and sustainability issues in RL systems as an integrated model to develop a complete performance framework model. The concept of RL can be implemented effectively and efficiently by the companies. This concept provides benefits for the company particularly in terms of cost. Companies do not need to make or repair the damaged parts without having to use natural resources. The more complex a product is made, the companies increasingly need RL strategy and modularity design product to minimize costs and increase profits at the same time. In other hand, Chinda [5] concluded the different drivers motivate companies to implement RL into their operational business. This paper is intended to calculate the costs should be allocated by companies that will implement RL strategy. The typical companies as the research objects in this study are electricity consuming companies. This type of companies were selected due to several return process in the company's system, while on the other hand, the RL system in such companies is complex and involves several actors. The other objective of this research is to analyze all potential drivers with the biggest percentage which can influence the implementation of

RL. Thus, companies would change the policies based on the condition to overcome the imminent issues.

2. Reverse Logistic (RL): Review and Implementation in Indonesia

In the study conducted by Pokharel and Mutha [1] concluded that RL research began around the 1960s. The research concerning with these topics have been developed according to the imminent problems faced at the time. RL has a definition as a system that has effective planning, processing, implementing and controlling process form of raw materials and finished products, all of which are integrated with the information on the amount of market demand and trying to use the waste to be reused into new product [1; 2]. Sangwan [6] reported that RL beginning from collection process from customers as end users. If the condition of the product can't be repaid, it can be transferred to the collection center. After that, products will disassemble into parts in disassembly center. If the parts have no value recovery, its will transfer to the disposal center. Furthermore, the implementation of the RL has provided some benefits for the government, customers, manufacture and environmental sustainability. The study by Kumar and Putnam [7] concluded that the implication of RL has impact on the energy savings of 74%, 90% raw materials, 97% mining waste, 88% air emissions, and 76% water usage. The company that implemented the RL system would obtain savings amounted to $ 43 billion [8]. Giri and Sharma [9] concluded that product recovery program which is one of the achievements of RL will have an impact on the decrease if life cycle of the frequently used products. In addition, a systematic approach of RL will improve the environmental impact and to ensure sustainable business [10 and 11]

There are not many research concerning with RL having been conducted in Indonesia due to limited data on the level of companies, distributors, wholesalers, retailers, and consumers as the end users. Some previous research that can be referred by the researcher are namely conducted by Meidiana and Gamse [12] reporting that Indonesian household wastes reaches the highest percentage (43.4%) among other sources of wastes, such as wastes from market (20%), streets (9%), public facilities (9%), offices (8%), industry (65), and others (4.6%). Relevant studies that have been conducted by Laurence et al. [13] and Hanafi et al. [14] stated that the RL concept has been implemented by some companies; even some companies put this concept as the main focus as they gain more benefit upon the implementation of the RL.

3. Results and Discussion

The novelty from this research compared with the research by Kroon and Vrijens [15], Hu et al [16], Pati et al [17], Jian-guo et al [18], Achillas et al [19], Ya-ping [20] and Dat et al., [21] is the existence of Service Center (SC) and 3rd Party Services (TPS) awareness as the new cost component. Both actors have significant contribution to TRLC. Figure 1 explains that return flow started from Customer until Disposal Center (DC). There are three alternative places to return the product i.e. SC, TPS and Distribution Center (store). TPS only has a function as a collection center. On the other hand, the repair function will be done by TPS and SC. TPS will make service claims to the company to repair products that are still under warranty period. The more damaged product condition and still under warranty, the greater the claim for the cost of repairing services charged to the company. After all damaged product collection in collection center, it will transfer into a recycled center. Some develop companies usually need Third Parties Services (TPS) and Service

Center (SC) to successfully implementation of RL. TPS is used to facilitate consumers to making claims (warranty period) and product repair. If the product is under warranty period, after repair the product, TPS will make service fee claim and component cost to the company. In other hands, SC is owned by the company. So there is no service fee charged to the company. If company produces poor in product quality, the company must be carried on all the cost both from TPS and SC. For companies whose sales system is already global, the existence of TPS and SC must spread in every city and proportional. In addition, another issue from the product service is the shorter waiting list for the consumers so they do not have to wait in line only in the official service center provided by the company. The calculation of the TRLC utilized Lingo Software to simplify the complex calculations because of the large number of variables and constraints. The mathematical model for calculating the TRLC can be expressed as:

$Min\, TRLC = TSC + THSC + TOCSC + TOTPS + THCC + TTUP + TTC + TDC + TTD + TTRC + THRC$. For TRLC constraints equation can be divided into six constraints i.e.: for

1. $\sum_k \sum_{sc} \sum_t Q_{ksc(t)} + \sum_k \sum_{sc} \sum_t S_{ksc(t-1)} - \sum_p \sum_{sc} \sum_t Q_{psct} \leq HC_{sc}$; (SC Holding Costs)
2. $\sum_p \sum_{rc} \sum_t Q_{prct} + \sum_p \sum_{rc} \sum_t S_{prc(t-1)} - \sum_p \sum_f \sum_t Q_{pft} - \sum_p \sum_{sm} \sum_t Q_{pSmt} - \sum_k \sum_{dc} \sum_t Q_{kdct} \leq HC_{rc}$; (RC Holding Costs)
3. $\sum_p \sum_{cc} \sum_t Q_{pcct} + \sum_p \sum_{cc} \sum_t S_{pcc(t-1)} - \sum_p \sum_{cc} \sum_t Q_{pcct} \leq HC_{cc}$; (CC Holding Costs)
4. $Q_{krt} \leq SC_{krt}$;
5. $Q_{krcdct} \leq DC_{krcdct}$
6. $Q_{krcdct} \geq 0$.

Where: TRLC= Total Reverse Logistics Costs, TTUP= Total Transportation Costs to Recycled Center, TSC= Total Service Costs, TTC=Total Transportation Costs SC and TPS to CC, THSC = Total Holding Costs Service Center, TDC=Total Disassembly Costs, TOCSC= Total Ordering Costs on Service Center, TTD=Total Transportation Costs to Disposal Center, TOTPS= Total Ordering Costs on Third Party, TTRC= Total Transportation Costs from RC to Factory, THCC= Total Holding Costs on Collection Center and THRC=Total Holding Costs to Recycled Center.

The study focuses on PCB Company, an electronic consumer as a preliminary investigation. The consumers of electronic industries produce the highest percentage of waste and the number is growing. PCB Company represents East Java, Indonesia. As the data collection method, the researchers use primary and secondary data. Table 1 shows the data of activity identification for Television "AKARI" LED 32". Based on the running program, it was obtained Global Optimum Solution (Table 2) at the iteration of 10529. The number of variables is 483 and constraints are 344. The model class is Integer Linear Programming (ILP) and solver type B-and-B class has been obtained cost of IDR 20,433,500 /cycle. After Global Optimum Solution founded, Figure 2 shows the proportion of the cost percentage incurred due to the activity of RL. The costs are: The highest is 52% from the Total Transportation Costs consisting of: Total Transportation Costs from Factory to Disposal Center (IDR 4,602,500), Total Transportation Costs from Recycled Center to Factory (ID 330,000), Total Collecting Product Costs (IDR 5,610,000) and Total Re-Distribution Warehouse Costs (IDR 1,475,000). Second, 36% from the Total Holding Costs consisting of: Total Factory Holding Costs (IDR 3,464,400), Total Recycled Center Holding Costs (IDR 770,600), Total Collection Center Holding Costs (IDR 2,277,000), Total Service Center Holding Costs

(IDR 147,000), Total Third Parties Services Holding Costs (IDR 462,000) and Total Distribution Center Holding Costs (IDR 305,000). And the last 12% from other costs namely: Total Disassembly Costs (IDR 900,000,-), and Total Disposal Center Costs (IDR 90,000).

4. Conclusion

The estimation of the Total Reverse Logistics Costs (TRLC) is intended to help the companies to know the estimated costs should be spent based on the number of actors and also the complexity of a combined system. By incorporating the Third Parties Services (TPS) attribute contributes significant impact because the number of defective products of PCB, Ltd. under warranty period returned to the service center is very large; as the company should bear the entire costs of the products leads to the mounting costs. Based on the Solver Status that has reached the Global Solution, it was obtained results of IDR 20,433,500 at the iteration of 10,529. The cost components consist of 52% from Total Transportation Costs, 36% from Total Holding Costs and 12% from others.

References and Notes

1. S. Pokharel, and A. Mutha, *Conservation and Recycling* 53, **(2009).**
2. S. Lambert, D. Riopel and W. Abdul-Kader, *Computers & Industrial Engineering* 61, **(2011)**
3. B. C. C. Bai, and J. Sarkis, *Journal of Cleaner Production* 47, **(2013)**
4. I. E. Nikolaou, K. I. Evangelinos and S. Allan, *Journal of Cleaner Production* 56, **(2013)**
5. T. Chinda, *Procedia Engineering* 182, **(2017)**
6. K.S., Sangwan, *Procedia CIRP* 61, **(2017)**
7. S. Kumar and V. Putnam, *International Journal Production Economics* 115, **(2008)**
8. S. E. Genchev, *Business Horizon* 52, **(2009)**
9. B.C Giri and S. Sharma, *Journal of Manufacturing Systems* 35, **(2015)**
10. S. C. Mangla, K. Govindan, and S. Luthra, *Journal of Cleaner Production* 129, **(2016)**
11. K. S. Khor, Z. M. Udin, T. Ramayah, and B.T Hazen, *International Journal Production Economics* 175, **(2016)**
12. C. Meidiana, and T. Gamse, *European Journal of Scientific Research* 40, **(2010).**
13. Laurence, J. Hanafi, and V. Anggrek, *Integra* 1, **(2011)**
14. J. Hanafi, H. J. Kristina, A. Christiani, A.V. Halim, D. Santoso, and E. Melini, *The 18th CIRP International Conference on Life Cycle Engineering*, **(2011).**
15. L. Kroon, and G. Vrijens, *International Journal of Physical Distribution & Logistics Management* 25, **(1995)**
16. T-L. Hu, J-B. Sheu and K-H. Huang, *Transportation Research Part E* 38, **(2002)**
17. R. K. Pati, P. Vrat dan P. Kumar, *International Journal Production Economics* 103, **(2006)**
18. X. Jian-guo, Q. Zhong and L. Jun-Hua, *International Conference on Wireless Communications, Networking and Mobile Computing IEEE*, **(2007).**
19. C. Achillas, C. Vlachokostas, D. Aidonis, N. Moussiopoulos, E. Lakovou and G. Banias, *Waste Management* 30, **(2010)**
20. C. Ya-ping, *International Conference on Business Computing and Global Informatization,* **(2012)**

21. L. Q. Dat, D. T. T. Linh, S-Y. Chou, and V. F. Yu, *Expert Systems with Applications* 39, **(2012)**

Figure Caption

Figure 1. RL Costs Flow

Figure 2. Cost percentage of each activity

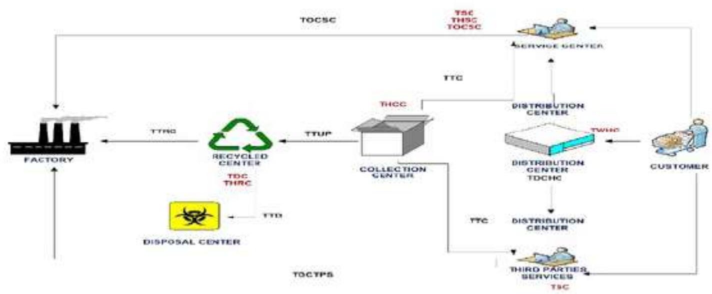


Figure 1. RL Costs Flow

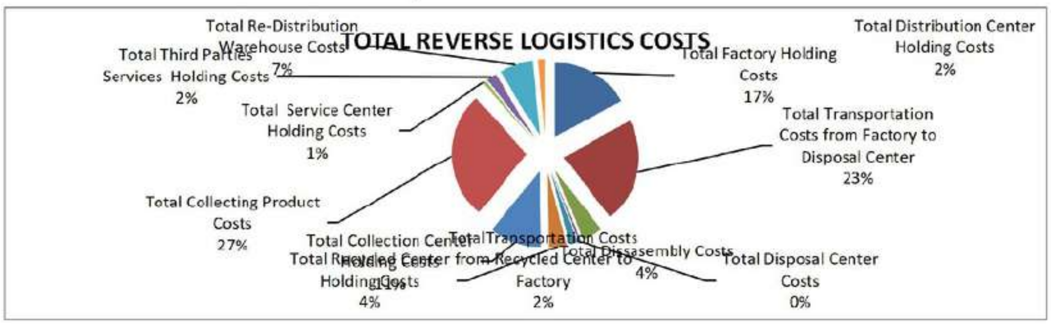


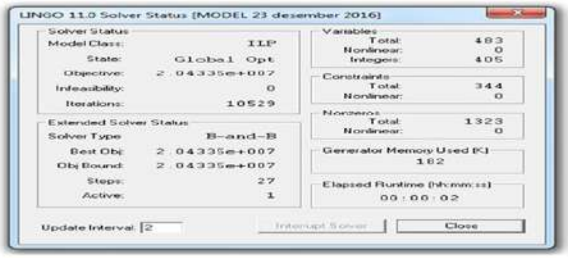
Figure 2. Cost percentage of each activity

Table Caption

Table 1. RL activity data

Actor	Activity	Quantity	Actor	Activity	Quantity	Actor	Activity	Quantity
CC	Inventory	700	DC	Inventory	80	RC	Inventory	200
	Capacity	400		Capacity	50		Capacity	1000
	CHpcct	700		Prob.of return	10		CHkrct	175 150 125
TPS	Invetory	50		Chpdt	500		CDkrct	250 300 350
	Capacity	20	SC	Inventory	150		Ckrdct	400 300 200
	CHptpst	700 600 700		Capacity	50		Creft	75000 65000 50000
	Cptpscct	16000 15000 12000		CHpsct	700		Mreft	500
	Cdtpst	50000 75000 50000		Cdsct	100000	DC	Percentage of DC	0.1
	Cptpst	100000		Cpsct	100000			
	Mdtpst	50 50 50		Mdsct	50 50 50			

Table 2. Solver Status


LINGO 11.0 Solver Status [MODEL 23 desember 2016]
Solver Status
Model Class: ILP
State: Global Opt
Objective: 2.04335e+007
Infeasibility: 0
Iterations: 10529
Extended Solver Status
Solver Type B-and-B
Best Obj: 2.04335e+007
Obj Bound: 2.04335e+007
Steps: 27
Active: 1
Variables
Total: 483
Nonlinear: 0
Integers: 405
Constraints
Total: 344
Nonlinear: 0
Nonzeros
Total: 1323
Nonlinear: 0
Generator Memory Used (K)
182
Elapsed Runtime (hh:mm:ss)
00:00:02
Update Interval: 2
Interrupt Solver
Close

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