A SYSTEM DYNAMICS MODEL ON REVERSE LOGISTICS PROFITABILITY OF HIGH VOLUME RETURNS WITH DETERIORATION IN COMPUTER INDUSTRY

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Abstract

This article presents the dynamic behaviour of five influential factors in computer manufacturer's reverse logistics (RL) operations, namely part type, return quality, market attractiveness, custom duty percentage and product deterioration rate on its profitability. Accordingly, a System Dynamics (SD) model has been developed to facilitate the manufacturers in managing the factors within their product return systems to maximize their profits. Secondary data from a case study is employed in the simulation experiments to evaluate the factors under high return volume and medium airfreight cost circumstances. The results provided in numerical forms show that the maximization of profitability can be achieved through buy part type, superior return quality, high market attractiveness, low custom duty percentage and low deterioration rate.

Keywords: Reverse logistics, System Dynamics, Profitability, Computer industry, Deteriorated returns

1. Introduction

As the world's largest and fastest growing manufacturing, computer and electronics industry has produced a huge number of its products in short periods. In the USA alone, some 600 million computers were rendered obsolete soon (www.werecycle.com). Globally, this figure will be over a billion computers. These electronic wastes (e-waste) contain toxic materials leading to environment deterioration. This problem has led to emergence of regulations and legislations from governments regarding e-waste management through reuse, repair and recycling in manufacturers' reverse logistics (RL) operations which engage companies' compliance (Pochampally *et al*., 2009).

From manufacturer's point of view, some additional costs should be allocated for managing RL as a burden to company's finance. However, product returns and their reverse supply chains do not automatically represent financial loss; instead enable companies to create a value stream. Moreover, treating the product returns as perishable assets due to their time value is recommended as one of the principles to improve asset recovery (Blackburn *et al*., 2004).

Beside part deteriorations occur at different rates during flowing in the reverse chain, there are other important factors to be considered in managing a profit-oriented RL for a computer manufacturer having market in many countries other than its recovery operations centre is held. In the returns collected at its service operations, two part types namely make and purchase parts, with different quality levels are found. In addition, custom duty percentages are different among countries where the collected returns are shipped to the recovery centre. Moreover, the recovered parts are sold to secondary markets with different attractiveness. Therefore, the question in this research is how to manage the interactions of these important factors, namely part types, return quality, market attractiveness, custom duty percentages and product deterioration rate, in a profit-oriented RL owned by a computer manufacturer.

The research aim is to support computer companies in developing effective and comprehensive returns management programs based on the development of a trade-off analysis methodology, and a cost assessment methodology to assess the impact of their returns operations on their profitability. Particularly, the research objective is to develop a system dynamics model regarding computer manufacturer’s RL to evaluate part types, return quality, market attractiveness, custom duty percentage and product deterioration rate factors in order to maximize its profit with implementation through a case study and to recommend optimal policies based on the results from the simulation. Some assumptions and limitations are determined in order to properly manage the systems complexity. While the assumptions applied in the model are normally distributed return volumes, linear deterioration rate, and a market demand for recovered parts; the limitations are single item part, returns acquired from repair service, high return volume, shipment by third party logistics (3PL), medium air freight cost, and overseas central recovery facility.

2. Selected Prior Studies on RL Profitability

An empirical study is conducted by Bernon and Cullen (2007) in order to identify the scale of returns, to explore and identify current management approaches related to reverse logistics and to develop a suggested framework for managing returns in the UK retail sector. The results shows that the use of such an integrated supply chain approach offers significant opportunities to reduce the cost of reverse logistics operations through significant avoidance of product returns while maximizing asset recovery values.

Mathematical models regarding RL profitability are developed in past studies for example Klausner and Hendrickson (2000), Srivastava and Srivastava (2006), Srivastava (2008), and Tan and Kumar (2008). A mathematical model to determine the optimal amount to spend on buy-back and the optimal unit cost of reverse logistics by selecting a suitable reverse-logistics system for end-of-life products is proposed by Klausner and Hendrickson (2000). The model with profitability criterion is applied to the remanufacturing take-back concept for power tools in Germany, using empirical data on the current take-back program.

In another study, two network design models are designed by Srivastava and Srivastava (2006) for three echelon reverse logistics systems with multi products such as televisions, cellular handsets, personal computers, refrigerators, washing machines and passenger cars. The three echelons are consumer returns, collection centre and rework sites for repair and remanufacture. In the first model which is developed by using GAMS software (General Algebraic Modelling Systems), cost is used as the performance criterion to determine simultaneously the location – allocation of facilities. Meanwhile, the second model, profit is utilized as the objective in order to determine disposition, location, capacity and flows in the reverse channels. This model is built using Mixed Integer Linear Programming (MILP).

Similar technique, MILP, is deployed again by Srivastava (2008) to develop a bi-level optimization model regarding a value recovery networks for three classifications of product returns. The model is formulated to determine the disposition decision for three products,

namely refrigerators, washing machines and passenger cars, in Indian context in order to maximize profits in a ten year period.
In the study of Tan and Kumar (2008), a decision making model is formulated to maximize the value of reverse logistics in the computer industry. The systems covering particular reverse channels, namely manufacturer, supplier, distributor and repair depot, and single product with make and buy parts is represented by using Linear Programming with profit as its objective function. The decision variables to be determined are disposition for make parts (repair, repackage or scrap) and buy parts (exchange or credit with supplier).

Moreover, previous studies on the profitability of supply chain deploy system dynamics approach such as the studies of Spengler and Schroter (2003), Georgiadis *et al.* (2005), and Tan and Kumar (2006). A strategic management of electronic spare parts in closed loop supply chain containing supplier, manufacturer and distributor in forward channel and recycling activity in backward channel is proposed by Spengler and Schroter (2003). The system dynamics approach is used to evaluate information and spare parts management under the influence of ageing process of equipment to maximize profit as an evaluation criterion.

Georgiadis *et al*. (2005) also utilize SD approach to evaluate effective policies and optimal parameters under capacity planning policy influences for multi-echelon food supply chain which consists of manufacturer, distribution centre and outlet. The SD model is developed to measure total supply chain profit.

Furthermore, Tan and Kumar (2006) study a decision-making model for original equipment manufacturer's (OEM's) reverse logistics in computer industry. The SD model evaluates return dispositions, collection point locations, transportation modes and recovered part pricing by using total profit as performance criterion. The model is validated by Dell Computer's case with its manufacturers in Malaysia, Singapore, USA, and customers in South East Asia.

In summary, the review of the selected prior studies on RL profitability provides sufficient insights regarding the systems of interest, the applied industries and countries, and modelling approaches. Generally, the systems of interest include forward logistics (supply chain, SC), reverse logistics (RL), and the combination of forward and reverse logistics (closed loop supply chain, CLSC). Additionally, a wide range of industries is highlighted in the studies, namely power tools, computer industry, retail sector, electronic spare parts, food, televisions, cellular handsets, personal computers, refrigerators, washing machines and passenger cars. Moreover, the studies take places in various countries which are Germany, India, UK, Malaysia, Singapore, USA and South East Asia Region. Furthermore, the methods employed in the studies cover empirical study, mathematical techniques such as optimum formulation, linear programming, mixed integer linear programming, and system dynamics. However, the existing literature does not cover the dynamic behaviour of part type, return quality, market attractiveness, custom duty percentage together with product deterioration rate factors on the profitability of reverse logistics managed by manufacturer in computer industry. The outcomes of this study contribute new knowledge to the existing literature regarding reverse logistics.

3. Methodology

In this research, a systems approach based on system dynamics methodology is employed to develop a system dynamics model of reverse logistics network with single perishable return part in computer industry to assess its profitability. Interdependence, mutual interaction, information feedback, and circular causality are contained in the reverse logistics systems. Due to these dynamic features or characteristics, system dynamics method is considered as

the appropriate method to be deployed in representing the essential characteristics involved in the observed systems (Sterman, 2000; Richardson, 2000).
As a computer-aided approach to theory building, policy analysis, and strategic decision support, system dynamics can be applied to complex social, managerial, economic, or ecological systems. Mathematically, the basic structure of a formal system dynamics computer simulation model is a system of coupled, nonlinear, first-order differential (or integral) equations, $d\,\mathbf{x}(t) / dt = \mathbf{f}\,(\mathbf{x},\mathbf{p})$, where $\mathbf{x}$ is a vector of levels (stocks or state variables), $\mathbf{p}$ is a set of parameters, and $\mathbf{f}$ is a nonlinear vector-valued function (Richardson, 2000).

As depicted in Figure 1, the SD methodology from Georgiadis & Vlachos (2004) is modified for designing a system dynamics model regarding reverse logistics in computer industry. The whole procedure in SD method is categorized into two analysing phases, namely qualitative and quantitative. The qualitative phase is initiated by thoroughly observing the systems under consideration, reverse logistics systems in computer industry, to facilitate the identification of the model objectives. Then, systems approach and analysis are applied to the observed systems by selecting properly all relevant entities and variables to the objectives in order to have a simplified and well-defined system. In the next step, the system is used its causal loop diagram which is then transformed into a stock and flow diagram. During the quantitative phase, the stock and flow diagram is translated to a simulation program using SD software for developing dynamic models. Once the initial models are gathered, they are iteratively verified and validated to obtain sufficient models. The program executions are performed under alternative what-if scenarios followed by analysing the results.

4. System Dynamic Model

As the objective of this research, a system dynamics model regarding RL in computer industry is described in this section. The model consists of causal-loop and stock-and-flow diagrams. It is followed by simulation experiments using a secondary case study to evaluate the dynamic influence of part types, return quality, market attractiveness, custom duty percentage and product deterioration rate factors on RL profitability.

4.1. Causal Loop Diagram

Figure 2 illustrates the causal loop of reverse logistics system in the computer industry. All variables included in the proposed causal loop diagram are described in Table 1. Causal loop diagrams are an essential tool for representing the feedback structure of systems. A causal loop diagram is constructed from variables connected by arrows denoting the causal influences among the variables. Positive (+) and negative (-) polarities assigned at the end of the arrows indicate the influence directions, how the dependent variables change when the independent variables change. While a positive sign describes both independent and dependent variables change in the same direction, a negative sign means the variables change in the opposite direction. A cluster of several variables forming a closed loop is highlighted by a loop identifier whether the closed loop is a positive (reinforcing) loop or a negative (balancing) loop. A reinforcing loop contains no negative arrow or even number of negative arrows. Meanwhile, a balancing loop is made of odd number of negative arrows. Both reinforcing and balancing loops can be clockwise or counter clockwise (Sterman, 2000).

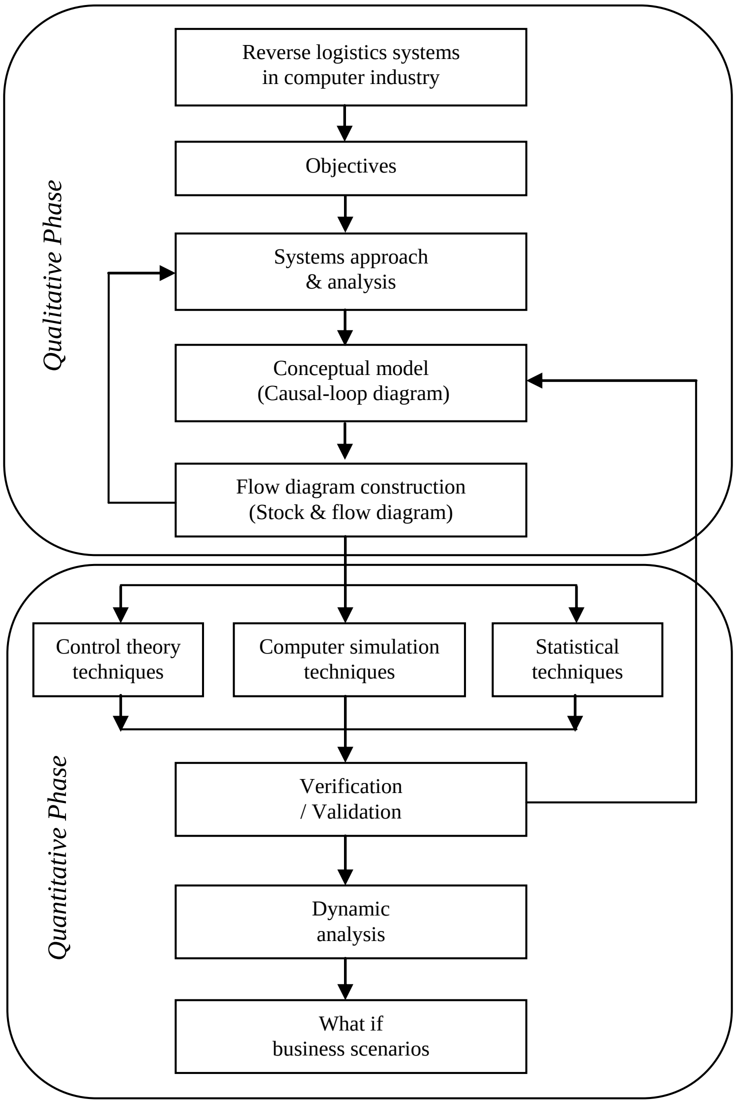

Figure 1. The system dynamics method (Adapted from Georgiadis & Vlachos, 2004)

There are two reinforcing loops in the figure. The details regarding the reinforcing loops are shown in Table 2. The first one is R1containing seven variables which are *profitability of reverse logistics*, *demand for returns*, *acquisition cost*, *return volume*, *collected returns*, *supplier's returns*, and *revenue of RL*. All variables in R1 have positive arrows or without negative arrow. Therefore, the increasing of a variable will also increase the next variable in the loop consecutively. Similarly, this behaviour occurs in the second reinforcing loop, R2, consisting of nearly equal variables except *manufacturing returns*, instead of *supplier's returns.*

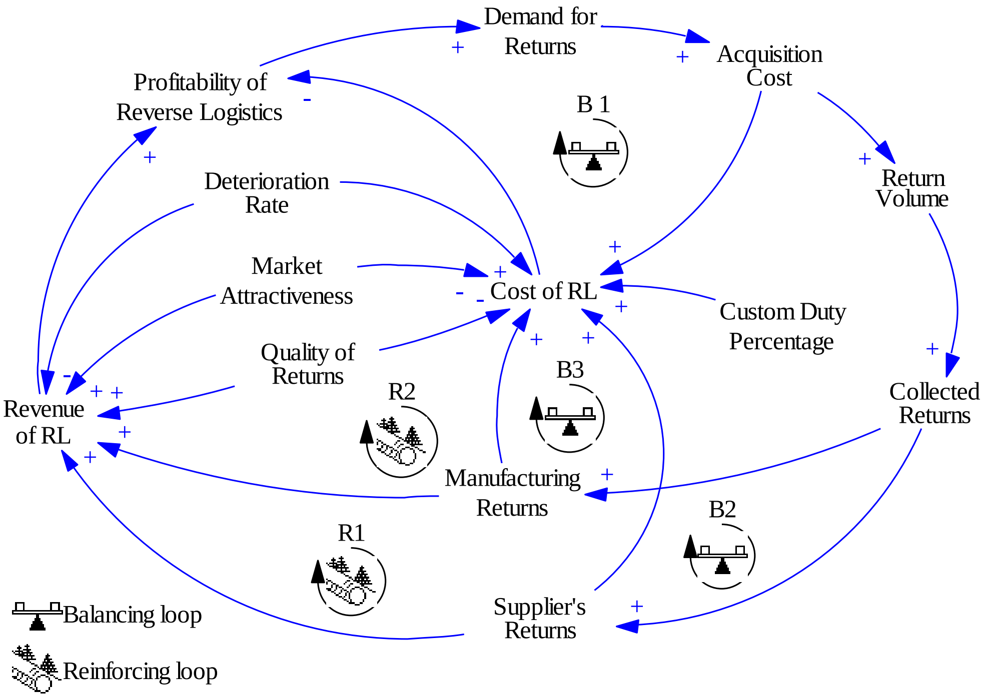

Figure 2. The causal loop diagram for reverse logistics in computer industry

Table 1. Description of variables in the causal loop diagram

Variables in the causal loop diagram	Variable descriptions
Profitability of reverse logistics	The profit obtained by computer manufacturer in managing its own reverse logistics
Demand for returns	The demand from computer manufacturer to collect part returns in its service centre
Acquisition cost	The cost paid by computer manufacturer to acquire a returned part
Return volume	The quantity of part returns supplied by customers to service centre
Collected returns	The quantity of part returns collected by service centre
Supplier's returns	The quantity of buy part returns to be transported to the corresponding supplier
Revenue of RL	The economic value of part returns that can be recovered in RL operations
Cost of RL	The cost allocated by computer manufacturing to manage its RL operations
Manufacturing returns	The quantity of make part returns to be transported to the computer manufacturing
Quality of returns	The quality level of the collected part returns
Market attractiveness	The comparison between resale price of recovered parts and the price of new parts in the secondary market
Custom duty percentage	The percentage of cost incurred in clearing each product return at the customs against the product return price
Deterioration rate	The decrease of the economic value of the returns overtime

In addition, three balancing loops, B1, B2 and B3, can be found in the figure. The details regarding the balancing loops are shown in Table 3. The first balancing loop, B1, is formed by four variables, namely *profitability of reverse logistics, demand for returns, acquisition cost* and *cost of RL*. There is merely one negative arrow in loop B1 to categorize the loop as a reinforcing loop, which is the arrow from *cost of RL* to *profitability of reverse logistics*. B2 as the second balancing loop is built by seven variables, which are *profitability of reverse logistics*, *demand for returns*, *acquisition cost*, *return volume*, *collected returns*, *supplier's returns*, and *cost of RL*. Meanwhile, the third balancing loop, B3, is also developed by seven variables consisting of the five initial variables in B2, *manufacturing returns* and *cost of RL*. The categorizations of B2 and B3 as balancing loops are determined by similar negative arrow from *cost of RL* to *profitability of reverse logistics*.

4.2. Stock and Flow Diagram

The stock and flow diagram for the reverse logistics systems is exhibited in Figure 3. It is constructed using variables categorized as stocks or levels represented by boxes, and flows represented by valves and constants. Valves are the rate of change in level variables and they represent those activities which fill in or drain the level variables. Constants are values that are used to compute the rate of change of level variables. Level variables represent accumulations in the system while flow variables are the rate of change in level variables and they represent those activities which fill in or drain the level variables. Delays are introduced into the model and these are the significant ones that have an impact on the material flow. Single-line arrows are information flows while double-line arrows are material flows in the model (Sterman, 2000).

Table 2. Variables and signs in the reinforcing loops

Loop identifiers	Variables in the loop	Arrow direction signs
R1	*Profitability of reverse logistics*	+
	Demand for returns	+
	Acquisition cost	+
	Return volume	+
	Collected returns	+
	Supplier's returns	+
	Revenue of RL	+
R2	*Profitability of reverse logistics*	+
	Demand for returns	+
	Acquisition cost	+
	Return volume	+
	Collected returns	+
	Manufacturing returns	+
	Revenue of RL	+

The diagram describes the reverse logistics operations of a computer manufacturing which has market in many countries other than where the recovery operations are held.

After collecting returns containing make and purchase parts from service operations, the collected returns are shipped to an overseas recovery facility centre. The reprocessing operations for make parts are reuse, repair, cannibalization and dispose-off. Meanwhile, the purchase parts require exchange, credit, cannibalization and dispose-off operations. All recovered parts are sold to secondary markets. The system description is based on the system studied by Tan & Kumar (2003, 2006). In addition, the system has been extended to cover the deterioration of part returns in this research.

Table 3. Variables and signs in the balancing loops

Loop identifiers	Variables in the loop	Arrow direction signs
B1	*Profitability of reverse logistics*	+
	Demand for returns	+
	Acquisition cost	+
	Cost of RL	-
B2	*Profitability of reverse logistics*	+
	Demand for returns	+
	Acquisition cost	+
	Return volume	+
	Collected returns	+
	Supplier's returns	+
	Cost of RL	-
B3	*Profitability of reverse logistics*	+
	Demand for returns	+
	Acquisition cost	+
	Return volume	+
	Collected returns	+
	Manufacturing returns	+
	Cost of RL	-

5. Simulation-based Experimental Design

Computer simulation based experiments are conducted to the SD model under a number of certain system constants representing the application environment of the model. The system constants are shown in Appendix 1. Independent or exogenous variables are often used to explore the dynamic characteristics of a model of a system (Forrester, 1999). Accordingly, the experiments in this study are designed to evaluate the dynamic behaviour of the reverse logistics system in computer industry against five factors or independent variables with different levels. The first factor is *part type* which has make and buy/purchase parts. The second one is *return quality* with three levels namely superior, average and inferior. The level values of *part types* and *return quality* are shown in Appendix 2. Moreover, the three different *return quality* of make parts are represented by *make part versus scrap ratio*, *reuse versus repair ratio*, *repair failure rate* and *cannibalization to scrap disposal ratio*. Meanwhile, the qualities of buy parts are measured through *buy part versus scrap ratio*, *credit versus exchange ratio* and *cannibalization to scrap disposal ratio*. *Market attractiveness* as the third factor has three different levels which are high, medium and low.

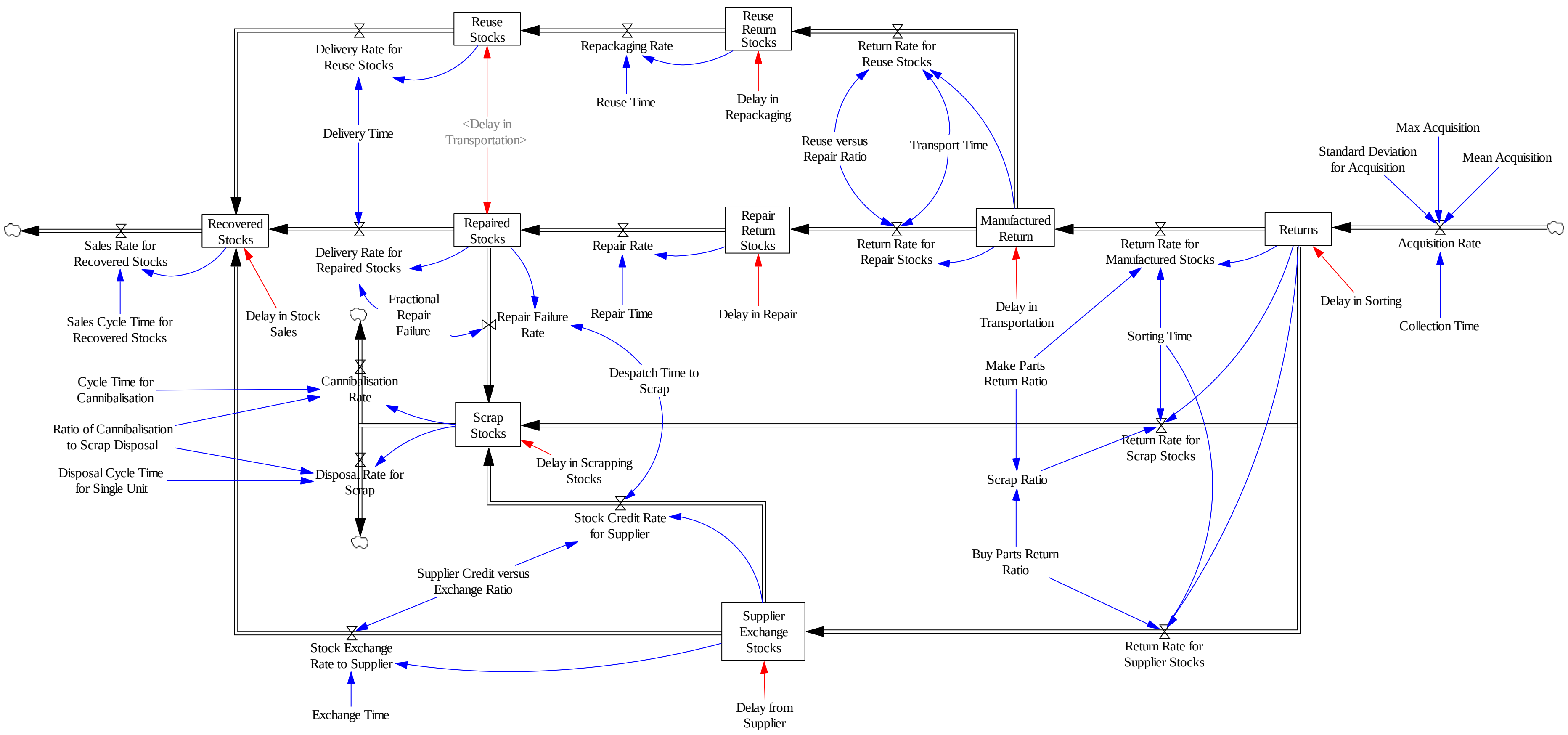

Figure 3. The stock and flow diagram for reverse logistics in computer industry

In the fourth factor, there is *custom duty percentage* factor with two different levels, namely no duty percentage and low duty percentage. The fifth factor called *deterioration rate* consists of three levels, low, medium and high deterioration rates. The level values of these three last factors are also presented in the Appendix 2. Based on the factors and their levels to be input in the experiments, there are 108 runs or trials which are executed by using data from the case study of Tan and Kumar (2003, 2006).

6. Analysis and Discussion

The results obtained from the experiments are demonstrated and discussed to have some interesting insights. All experiment runs result in 108 graphs representing 108 weekly profitability behaviours. Figure 4 shows six initial simulation runs by using six initial scenarios representing *make part*, superior *return quality*, high *market attractiveness*, two *custom duty percentage* levels and three *deterioration rate* levels. In general, the graphs have maximum *weekly profits*. Trials 1 and 4 have maximum values which are $73,303 and $82,032 respectively at week 23. The maximum *weekly profits* for trials 2 ($82,267) and 5 ($92,052), take place at week 34. Two other trials, 3 and 6, have $94,054 and $104,881 *weekly profits* as their maximum values at week 35. After the maximum points, the *weekly profits* decrease gradually. It is largely due to the effect of *deterioration rate* where the return values reduce continuously with respect to time. Another insight from a group of graphs 1, 2 and 3 and another group of graphs 4, 5 and 6 is the lower *deterioration rate* leads to the higher *weekly profits*. Moreover, the comparisons of graphs 1, 2 and 3 to graphs 4, 5 and 6 consecutively exhibit that the lower *custom duty percentage* results in the higher *weekly profits*.

The cumulative weekly profitability in two years (104 weeks) for the 108 scenarios are shown in Figure 5 as 54 profit pairs of make and buy *part types*. The effect of *part types* to the profitability of reverse logistics is shown by the profit gaps in every profit pair. These groups state that the buy parts have higher profitability than the make parts for all superior and average *return quality* experiments. It is caused by the lower cost of exchange parts compared to the repackaged and repaired parts. The cost of exchange parts are transportation, administration and storage costs as mentioned by Tan and Kumar (2006). Meanwhile, the groups for inferior *return quality* have the same cumulative profits between buy and make *part types*. It occurs because the inferior *return quality* results in scrapped returns to dispose-off with the same revenues and costs for both *part types*.

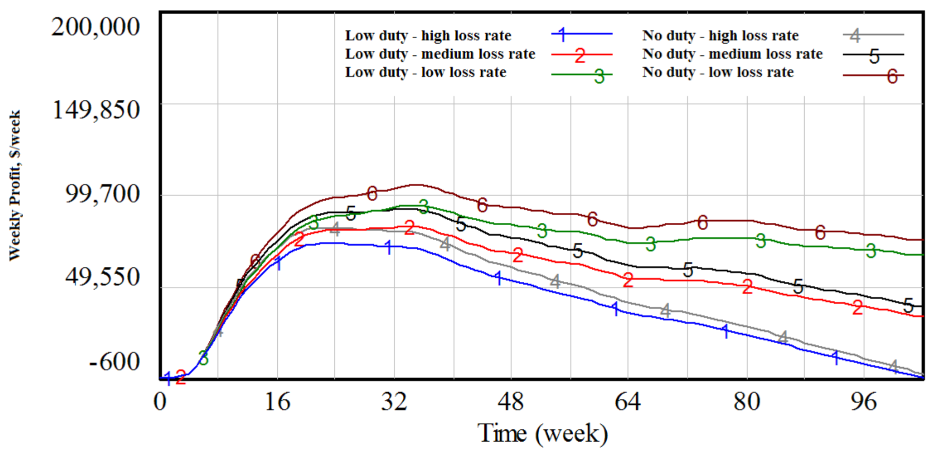

Figure 4. The behaviour of weekly profitability for six initial runs in a two year period

The influence of *return quality* factor to the systems performance is described by the clusters of three points with 18 point lags, for example the 1st, 19th and 37th points. While lower *quality returns* generate losses regardless of return volume and part type (Tan and Kumar, 2006), the observations to the above clusters provide insights that the lower *return quality* leads to lower profit except for the scenarios containing simultaneously make part, average quality, low attractiveness and high deterioration where the profits of inferior quality are slightly higher than the average ones. These two states are triggered, on one hand, by the effect of quality to the volumes of repackaged, repaired and scrapped parts, and on the other hand, by the stronger influence of high *deterioration rates* to the decreasing of the *revenue*.

The groups of three points with 6 point lags such as the 1st, 7th and 13th points, and the 19th, 25th and 31st points represent the role of *market attractiveness* to the system criterion. These groups show that the lower *market attractiveness* has some consequences which are lower profits for superior and average *return quality*; the same profits for inferior *return quality* with no *custom duty*; and higher profits (or lower deficits) for inferior *return quality* with low *custom duty*. The first consequence is affected by the lower *item selling price* which leads to the lower *revenue*. Concerning second one, it is caused by (i) the inferior *return quality* results in all returns as scrap for disposal, where its revenue is not influenced by the *market attractiveness*, but by its weight and its constant price; (ii) the zero *custom duty percentage* leads to the same *fixed costs*, *total scrap cost* and *total unit scrap cost* for different *market attractiveness*. Meanwhile, the third one has occurred since the lower *market attractiveness* decreases the following dependent variables: *item selling price*, *custom duty*, *fixed costs*, *total scrap cost*, and *total unit scrap cost*.

The *custom duty percentage* effect on profitability can be analysed from the groups of two points with 3 point lags such as the 1st and 4th points and the 2nd and 5th points, showing that lower *custom duty percentages* lead to higher profits for all scenarios. It is largely due to the significance of this factor to reduce *fixed costs*, *total costs* and *total unit costs*, while other factors have no change.

The role of *deterioration rate* factor can be observed from the clusters of three consecutive points. Some insights can be gathered from these clusters. The first insight is that the lower *deterioration rates* result in the higher profits for superior and average *return quality*. It is due to the impact of higher *item selling price* to higher *revenue* for recovered parts. The second one is that the lower *deterioration rates* do not change the profits for inferior *quality returns* with no *custom duty*. This situation explains that inferior *return quality* leads to scrap all the returns, and then making *deterioration rate* has no effect to the *revenue* and *the cost of scrap*; no *custom duty* makes lower *deterioration rate* has no effect to *fixed cost*. The last one is that the lower *deterioration rate* scenarios lead to lower profits on inferior *return quality* and low *custom duty* conditions. It has occurred because low *custom duty* makes lower *deterioration rate* producing higher *custom duty* that triggers higher *scrap cost* or *unit scrap cost*.

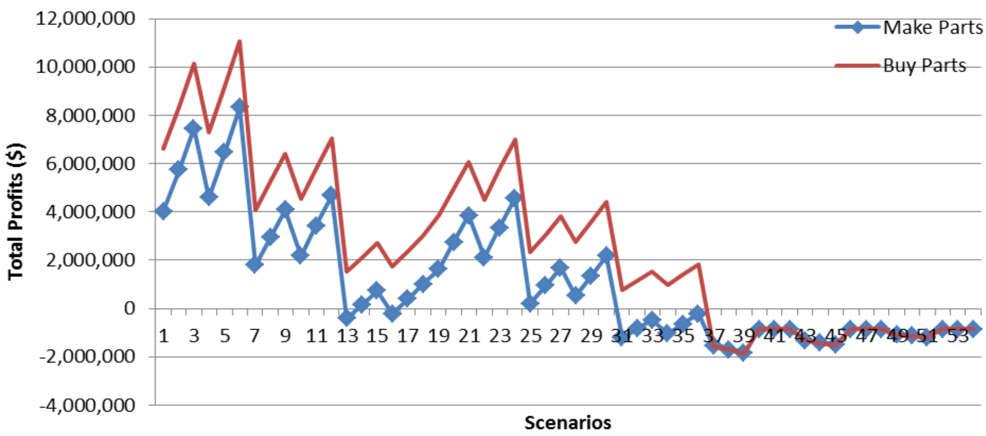

Figure 5. The two year cumulative weekly profitability for make and buy parts

7. Conclusions

A system dynamics model regarding computer manufacturer's RL to maximize its profit with implementation through a case study using secondary data has been developed. The RL operations cover collection, repackage, repair, exchange, cannibalization, disposal and sales activities. The part returns are acquired from service operations in many countries before shipping using third party logistics (3PL) to another country where the recovery operations are performed to gain the economic value remaining in the returns.

Additionally, the simulation-based experiments through five exogenous variables, namely part type, return quality, market attractiveness, custom duty percentage, and deterioration rate, has been performed. The results suggest that profit maximization can be achieved by the computer company through buy part type, high quality returns, high market attractiveness, low custom duty percentage, and low computer part deterioration rate. The resulting model facilitates computer manufacturing with an experimental tool to maximize their profits by putting the values of constants and independent variables in their real RL systems to the model.

Specifically, the contribution of this study is to incorporate the deterioration rate of computer part when managing its reverse logistics operations. Some assumptions and limitations have been applied in the model. While the assumptions are normally distributed return volumes, linear deterioration rate, and the availability of market demand for recovered parts; the limitations are single item part, returns acquired from repair service, high return volume, shipment by third party logistics (3PL), medium air freight cost, and overseas central recovery facility. Further studies can be conducted by altering any part in the assumptions and limitations.

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Appendix 1. Model constants

- *Air Freight Cost* = 1.6 $/kg
- *Average Cost to Repackage* = 200 $/pc
- *Average Cost to Repair* = 500 $/pc
- *Average Cost to Scrap* = 30 $/pc
- *Collection Time* = 1 week
- *Cycle Time for Cannibalisation* = 8 week
- *Delay from Supplier* = 0.5 week
- *Delay in Repackaging* = 0.5 week
- *Delay in Repair* = 0.5 week
- *Delay in Scrapping Stocks* = 1 week
- *Delay in Sorting* = 0.5 week
- *Delay in Stock Sales* = 2 week
- *Delay in Transportation* = 0.2 week
- *Delivery Time* = 4 week
- *Despatch Time to Scrap* = 4 week
- *Disposal Cycle Time* = 1 week
- *Exchange Time* = 6 week
- *FINAL TIME* = 104 week
- *Initial New Item Selling Price* = 2000 $/pc
- *INITIAL TIME* = 0
- *Item Weight* = 5 kg/pc
- *Labour cost per hour* = 100 $/hr
- *Max Acquisition* = 120 pc/week
- *Mean Acquisition* = 98 pc/week
- *Number of hours per transaction* = 1 hr/pc
- *Number of items* = 1000 pcs/pallet
- *Price of Scrap* = 10 $/kg
- *Purchase Cost* = 0 $/pc
- *Repair Time* = 2 week
- *Reuse Time* = 1 week
- *Sales Time for Recovered Stocks* = 4 week
- *SAVEPER* = *TIME STEP*
- *Sorting Time* = 1 week
- *Std. Deviation for Acquisition*= 17 pcs/week
- *Storage cost per pallet* = 100 $/week/pallet
- *TIME STEP* = 1 week
- *Transport Time* = 3 week

Appendix 2. Independent variables

Part Types	Quality Parameters	Return Quality		
		Superior	Average	Inferior
Make	*Make part versus scrap ratio*	1	0.66	0
	Reuse versus repair ratio	1	0.5	0
	Repair failure rate	0	0	0
	Ratio of cannibalisation to scrap disposal	1	0.5	0
Buy/Purchase	*Buy part versus scrap ratio*	1	0.66	0
	Ratio of credit versus exchange	1	0.5	0
	Ratio of Cannibalisation to Scrap Disposal	1	0.5	0

Factors	Unit	Levels	Level Values
Market Attractiveness	Per cent	High	75
		Medium	50
		Low	25
Custom Duty Percentage	Per cent	No	0
		Low	8
Deterioration Rate	Per cent	Low	25
		Medium	50
		High	75