Closed loop supply chain network with LCC

Elkhan Hasanov[1], Parviz Hasanov[1], Yadullah Babayev[1]

[1]*Baku Engineering University, Azerbaijan*

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Corresponding authors:
elhesenov@beu.edu.az

Abstract

Economic growth increases production and result of this increased consumption and waste. Considering the amount of waste generated every year the managing of waste is quickly becoming a tremendous problem for the environment. Thus manufacturers and the general public have come to recognize the importance of waste management. The aim of the paper is to revisit an EOQ type reverse logistics model Ritcher (1996a,b) and highlights the potential benefits of developing recycle methodology in the manufacture and remanufacture. Figures and mathematical models are developed and results investigated with examples. The developed model was compared with the model of Ritcher (1996a,b) to stress the importance of waste management.

Keywords: supply chain, logistics, recycle methodology

1.Introduction

Competitive business environment forces firms to grow their economies and increases their production. Therefore, if firms want to increases their production they have to extract from the environment more raw materials to produce a new product. After the end of the lifecycle of this new product, waste increases and create pollution. Buried or decompose of this waste in the landfill sites, may generate the dangerous gases and affect the valuable resources. These dangerous gases are also contributing climate change in a bad way. The government has recognized the problem and so they give support to firms for solving this problem.

On the other hand, firms want to produce the cheapest new product for sell more than their competitor. So firms always prefer cheap raw materials to produce a new product. Recycle waste materials may help the firms to achieve these goals and it will reduce the waste, that may solve the waste problem which written above.

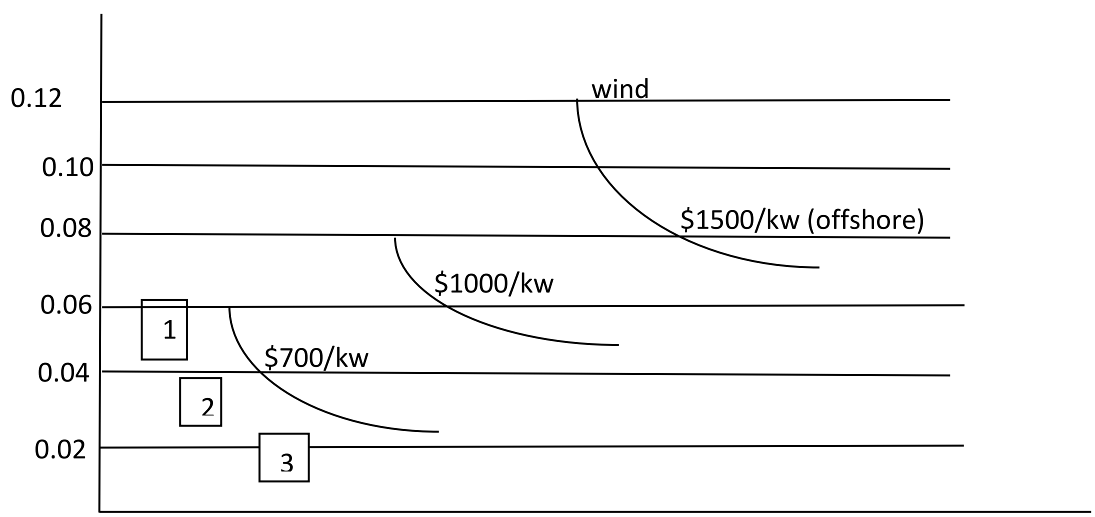
Recycle is "the series of activities by which discarded materials are collected, sorted, processed and used in the production of new products" (King et al. 2006). Making product from raw materials usually requires more energy than making the same product from recycled material. Many product categories, computers, printer cartridges, car batteries can be made new in this way (Samar K. M, 2009). There are many examples that support this;

1. It takes 25 times as much energy to make an aluminum item from raw materials as from recycled aluminum.
2. About 90% of Kodak one-time use cameras are produced from recycled camera bodies.
3. Producing recycled paper results in 75% less air pollution and 35% less water pollution than making a paper product from trees e.g.
4. Automotive component can be recycled (Lily A. et.al.2009)

In this model, we compare Wind energy (renewable energy) and conventional energy. Production and selling electricity from the wind is no different from any other business. Generally, the cost of generating electricity is made up from;

1. Capital cost- building the power plant and connecting it to the grid,
2. Running cost – operating, fuelling, and maintaining the plant,
3. Financing – the cost of repairing, investors and banks.

Figure-1: Cost Comparison for Different Energy Sources (wind power monthly Jan.2002)



1: nuclear; 2: coal; 3: gas

The lower capacity of wind power means that to produce a given quantity of electricity it is necessary to install 2-2.5 times more generating capacity than with fossil flue plants. This tends to make wind energy more expensive in the initial phase of the life cycle. On the other hand, there is no fuel cost during the lifetime of a wind power generating plant Figure-1.

To determine the true cost of generating electricity the cost of pollution and other external costs (human health and environment) should be included in the calculation.

El Kordy et al. analyzed the external cost of different systems. A life cycle cost (LCC) analysis for each system was performed using the present value criterion. Their comparison results showed that wind energy generation has the lowest cost.$LCC = C_{pw} + M_{pw} + F_{pw} + X_{pw} - S_{pw}$

pw: present worth of each factor

C: capital cost (initial capital expense for equipment, system design, system engineering and installation)

M: operation and maintenance cost (salaries for operation, inspection and insurance)

F : is fuel cost

X : external costs including damage prevention or damage cost

S : is the salvage value of the system

We can get values from El Krody et al. And can develop two model which are

2. Assumptions and notations

The assumptions and notations in this paper are the same as those made by Ritcher (1996a,b), except for those related to recycling.

2.1 Assumptions

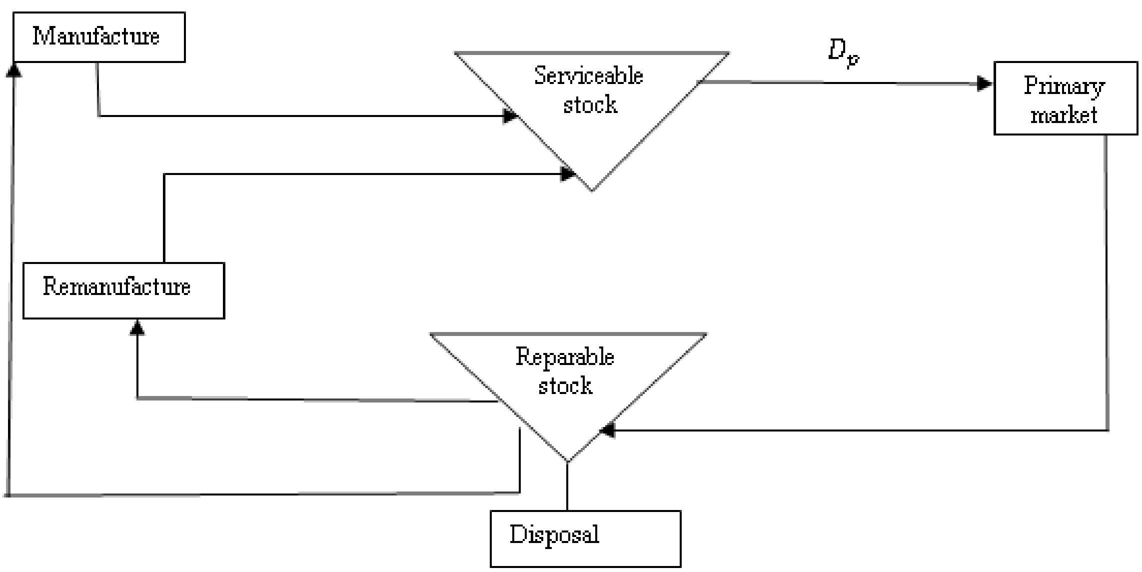
1. A single product case with same qualities.
2. Instantaneous production and recovery rates.
3. Demand for produced, remanufactured and are known, constant but different.
4. Constant but different collection rates for previously used manufactured, remanufactured and recycle items.
5. Lead time is zero.
6. Unlimited storage capacity is available.
7. Infinite planning horizon

3. Model development

The production, remanufacturing, and waste disposal model described in Fig. 2., which is similar to that of Richter (1996a,b) except for the assumption that some percentage of waste used for recycling for production. The system consists of two shops. Remanufactured and produced items are stored in the first shop (serviceable stock), while the used items are stored in the second (reparable stock). Used items are screened and items that are considered to be not repairable are recycling and send to for the manufacturing. There are m remanufacturing and n production cycles in interval T.

This paper considers some percentage of used items which are cannot be recoverable that are recycled, and send to the manufacturer for produce new items.

Figure-2: Material Flow for a Production, Recycle and the Remanufacture System



3.1 Model

The total cost per cycle for this case is the sum of the setup costs for recycling, remanufacturing and production batches, the holding cost for items in the serviceable stock, and the holding cost for items in the reparable stock. This paper, as many other in the literature, assumed that recovered (repaired, remanufactured) items of a product is as-good-as-new.

1. TC = Set up cost for remanufacture, manufacture and recycle +life cycle cost for conventional energy+ transportation costs + disposal cost+ holding costs for

remanufacture,manufacture and recycle + holding used item costs for remenufacture and manufacture

2. TC = Set up cost for remanufacture, manufacture and recycle life cycle cost for wind energy + transportation costs + disposal cost+holding costs for remanufacture,manufacture and recycle + holding used item costs for remenufacture and manufacture

4. Numerical examples

In this section, three numerical examples solved whose parameters were selected from Ritcher (1996a,b). In this study assumed that remanufactured items as-good-as-new like other studies in the literature and also accounted the life cycle costs of energy (LCC), transportation costs between the locations (A), and landfill costs whose parameters were collected several studies.

4.1 Model-1

Example 1: Ritcher (1996), Let : $S_p = 20$, $S_r = 100$, $d = 10$, $h_u = 4$, $h = 6$, $\alpha = 0.5$, $LCC^w = 1.8085$(wind energy cost for one location), $WC = 45$, $A = 10$(transportation cost between two location)

Then for instance $x(1,1,0.5) = 25.183$, $x(2,1,0.5) = 31.483$, $x(1,2,0.5) = 27.893$, $x(1,3,0.5) = 29.662$ hold. $TC(1,1,0.5) = 172.185$,$TC(2,1,0.5) = 201.255$, $TC(1,2,0.5) = 169.796$, $TC(1,3,0.5) = 173.152$ hold.

4.2 Model-2

Example 1: Ritcher (1996), Let : $S_p = 20$, $S_r = 100$, $d = 10$, $h_u = 4$, $h = 6$, $\alpha = 0.5$, $LCC^{fo} = 5.4256$(conventional steam fuel oil fired energy cost for one location), $WC = 45$, $A = 10$(transportation cost between two location)

a). Then for instance $x(1,1,0.5) = 25.392$, $x(2,1,0.5) = 31.662$, $x(1,2,0.5) = 28.105$, $x(1,3,0.5) = 29.87$hold. $TC(1,1,0.5) = 173.616$, $TC(2,1,0.5) = 202.4$, $TC(1,2,0.5) = 171.087$, $TC(1,3,0.5) = 174.367$ hold.

b). $LCC^{gf} = 2.43$(conventional steam natural gas fired)

Then for instance $x(1,1,0.5) = 25.22$, $x(2,1,0.5) = 31.514$, $x(1,2,0.5) = 27.929$, $x(1,3,0.5) = 29.698$ hold. $TC(1,1,0.5) = 173.432$, $TC(2,1,0.5) = 201.452$, $TC(1,2,0.5) = 170.018$, $TC(1,3,0.5) = 173.361$ hold.

5. Conclusion and summary

In this paper revisited Ritcher (1996) then accounted energy cost, transportation cost, and waste cost. Firms consume more energy, extract more raw materials and improve transportation systems while increasing their production. The result of this occurs more pollution, and increase waste.

These costs were not considered other studies while investigated EOQ model in reverse logistics. But when we compare results with Ritcher (1996), it showed that these costs hold an important part of the total cost and lot size increases while considering energy, transportation, waste costs. And also showed that renewable energy has the more economical and social benefits and the more friendly environment than non-renewable energy while considering external costs of energy.

This study was conducted to provide insights needed to give research direction to the field, to consider the effect of energy, transportation, and waste in further studies and developing the more friendly environment models.

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