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Design Of Supply Chain Network Model And Optimization

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Abstract

A supply chain network model is designed between Trivandrum and Tirunelveli. In this developing world, recycling is essentially driven by economic necessity, with the associated environmental benefits it is being a useful and positive by-product. The main incentive for recycling waste is its residual economic value. When waste has intrinsic economic value, it becomes a commodity and can be recovered, sold transformed and converted for re-use, adding value along every step of the process. In this research work a supply chain network model is designed, it expresses the expected annual logistics management cost and an optimal path is selected with keeping in mind with future technological, political, seasonal constraints.

Keywords: Logistics, Recycling, Optimization, Network model, Cost minimization

INTRODUCTION

A supply chain can be viewed as a network where the nodes represent functionality that must be provided and the arcs capture precedence constraints among the functions(1). There are a lot of research efforts in many different disciplines attempting to find technologies and ways to make a cleaner and sustainable world. Kerala is very much developing destination with lot of construction sites. Increase in petroleum price is also one of the major problems now a day. A supply chain network model is designed between Trivandrum and Tirunelveli. This system consists of four sites with roofed storage capacity, the purpose of this study is to analyse the available method of transportation by road, railway and to suggest the best method of transportation. Based on the best system configuration for each scenario, alternative configurations were designed in detail and compared under potential transportation scenarios. With the clear understanding of the risks and expected benefits involved in transporting the waste for recycling.

The main focus is on municipal solid waste, which is taken to include waste from households, businesses and institutions, construction and demolition waste in small quantities, general solid wastes from hospitals (excluding hazardous wastes), waste from smaller industries that is not classified as hazardous, and wastes from streets, public areas and open drains. It is not concerned with wastes from agriculture, larger industries or the mining industries which normally handle their own wastes. Such wastes are generated in huge quantities in many countries, but the systems for collecting, treating and disposing of them are separate from the systems used for municipal solid waste.

The research is set out to achieve the following objectives:

(a) Identify and map logistical factors with ecological flows of waste in the Area between Trivandrum and Tirunelveli regions.
(b) Identify opportunities and logistics solutions to improve the supply chain efficient collection, trading, Transportation, storage and sorting with optimal path.
(c) To design an optimal logistic cost reduction equation.

LITERATURE SURVEY

Optimising the distribution network is determining the best location for each facility, setting the proper system configuration and selecting the right carriers. It brings immediate cost advantages of 20 to 30 percent (3). This typically breaks down the transportation savings of 15 to 25 percent and improvements in inventory-carrying costs of 10 to 15 percent (11). Environment is becoming one of the most significant issues facing contemporary logistics managers (2). Freight transport is frequently a major component of life-cycle impact (12). Logistics managers have to become more sophisticated in their understanding of how they can reduce the environmental impact of their logistics operations, without negatively affecting the cost or effectiveness of these operations (9). Since 1990s there has been an increasing effort to examine the best ways to reduce congestion, conserve resources, reduce of emission, and recycle in the logistics activities (5). Governments are becoming increasingly aware that the poor quality of service provided in most urban areas, in terms of the quantity of solid waste collected and the environmental protection provided, makes it difficult to justify even the present levels of expenditure in this sector. There is, therefore, increasing demand for greater efficiency. Of the total expenditure incurred in solid waste management, typically 70 to 80 percent4 is directed towards the collection and transporting of wastes.

It is an efficient service for minimisation of solid waste collection costs, together with the provision of an adequate and regular service to all of the target area. In order to achieve these objectives, solid waste management systems should evolve indigenously, based on the quantity and character of the waste, wage rates. The main benefit factor is land filling, according to a study by the World Business Council for Sustainable Development (WBCSD), over a million cubic metres of landfill space per year would be saved if all households recovered their paper.

Environmental Policy

In the U.S.A., an estimated 75 percent of consumers claim that their purchasing decisions are influenced by a company's environmental reputation, and 80 percent would like to pay more for environmental friendly goods (Lamming and Hampson, 1996). On a worldwide level, a recent 22-country survey of environmental attitudes (Elkington, 1994) found that:

• In half of the countries surveyed, the environment was considered on the three
most serious problems.

• In most countries, the majority of the citizens surveyed said that the state of the environment affects their health, and an even greater majority says that the environment affects the health of their children.

• In 16 of the 22 countries, citizens said that they avoid products that are harmful to the environment.

One of the environment-related laws in Japan is the "Waste Disposal Law." It requires that "waste should be processed properly." Another "Recycling Law'^ is being written. The home appliance recycling law requires appliances like televisions, refrigerators, washing machines, and air conditioners to be returned to the producers at the end of life and be processed properly. Legislation for recycling computers will be considered in about 5-10 years. Another Asian country, Taiwan, has enacted electronic waste take-back legislafion in 1998.

In Germany, the waste packaging ordinance law and the associated DSD scheme impose a duty along the supply chain to accept all returned packaging from customers and to arrange for its recycling or re-use. Several other European countries (Austria, Belgium, Denmark, Italy, Netherlands, Norway, Sweden, and Switzerland) have legislation addressing the take-back and treatment of electronics waste either under discussion, in preparation, or already enacted (Boks et al., 1998).

In brief, this various legislation regulates that the producers or importers are responsible for their end of life products and are obligated to take them back from the last owner and that these end of life products should be properly processed from an environmental perspective, especially the European Commission. In July 1999, Kopacek (1999) issued the draft of a "proposal for a Directive on Waste from Electrical and Electronic Equipment (WEEE)." The Commission's goals are to minimize the risks and impacts to the environment associated with the treatment and disposal of end-of-life electrical and electronic equipment.

Although the product take-back legislation will most directly affect European companies, it will also affect U.S. companies operating in the European market. Some states including North Carolina, Wisconsin, Minnesota, and Califomia have shown initiative toward product take-back plans. And over 30 of the states prohibit the placement of appliances into the landfill, which encourages end-of-life organizations to recycle or reuse the end-of-life appliances (Boks et al., 1998). This research aims to benefit local authorities in general. The analysis of environmental impacts based on life cycle assessment will allow local authorities to understand the impacts of not just the recycling collection scheme, but also the wider issues related to the minimizing the cost of logistics system.

EXPERIMENTATION

Nowadays, many disciplines are trying to find ways to make a cleaner world and at the same time ensuring sustainable supply of energy and resource for the growing population (10). In this research work of logistics, an attempt is made to which investigate ways to reduce fuel consumption and find a optimal path of transportation activities. Meanwhile, the supply chain research has been dominated by the 'forward' supply chain view focusing in the efficient movements of materials with supply chain models, which are designed for carrying the wastes, are shown in figure 1. The model has four sites parallel with train and road transportation.

Main constraints which consumes costs are

1.Rent for ware houses
2.Loading and unloading cost
3.The nature of material cost
4.Holding cost, shortage cost, excess cost and all inventory costHer

5. The method of transportation and combination of all practical method of transportation
(rail and road)

In this model shown in figure 1, here the transportation of goods from 3to 4 in rail is almost impossible due to various constraints. The transportation from 1 to 2 and 2 to 3 is done by rail and it is taken by road from 3 to 4. Here the transportation cost will be reduced from 1 to 2 and 2 to 3 because rail is much cheaper than road. But the total cost will have another unloading and reloading cost factor to be considered in total cost and has to be analysed with total cost.

Here 1 is Trivandrum and 4 is Tirunelveli.

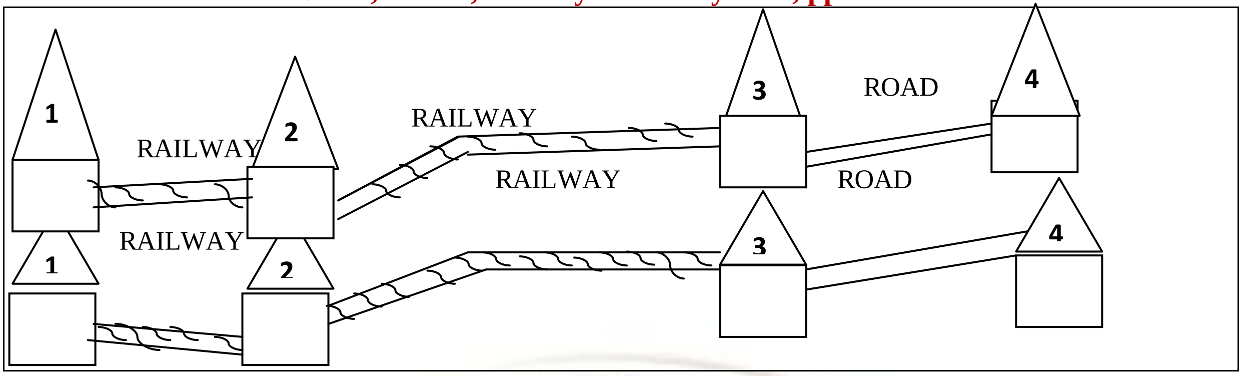

Figure 1 Efficient Model for optimal route

Here Cost minimization is focused on day-to-day operations, but it also may involve making strategic choices about such issues as outsourcing and process design. The reduced costs in such areas as inventory management, transportation, warehousing, which result as effective Supply-chain-related achievements (6). In figure 2 various stages of waste collection is shown by road.

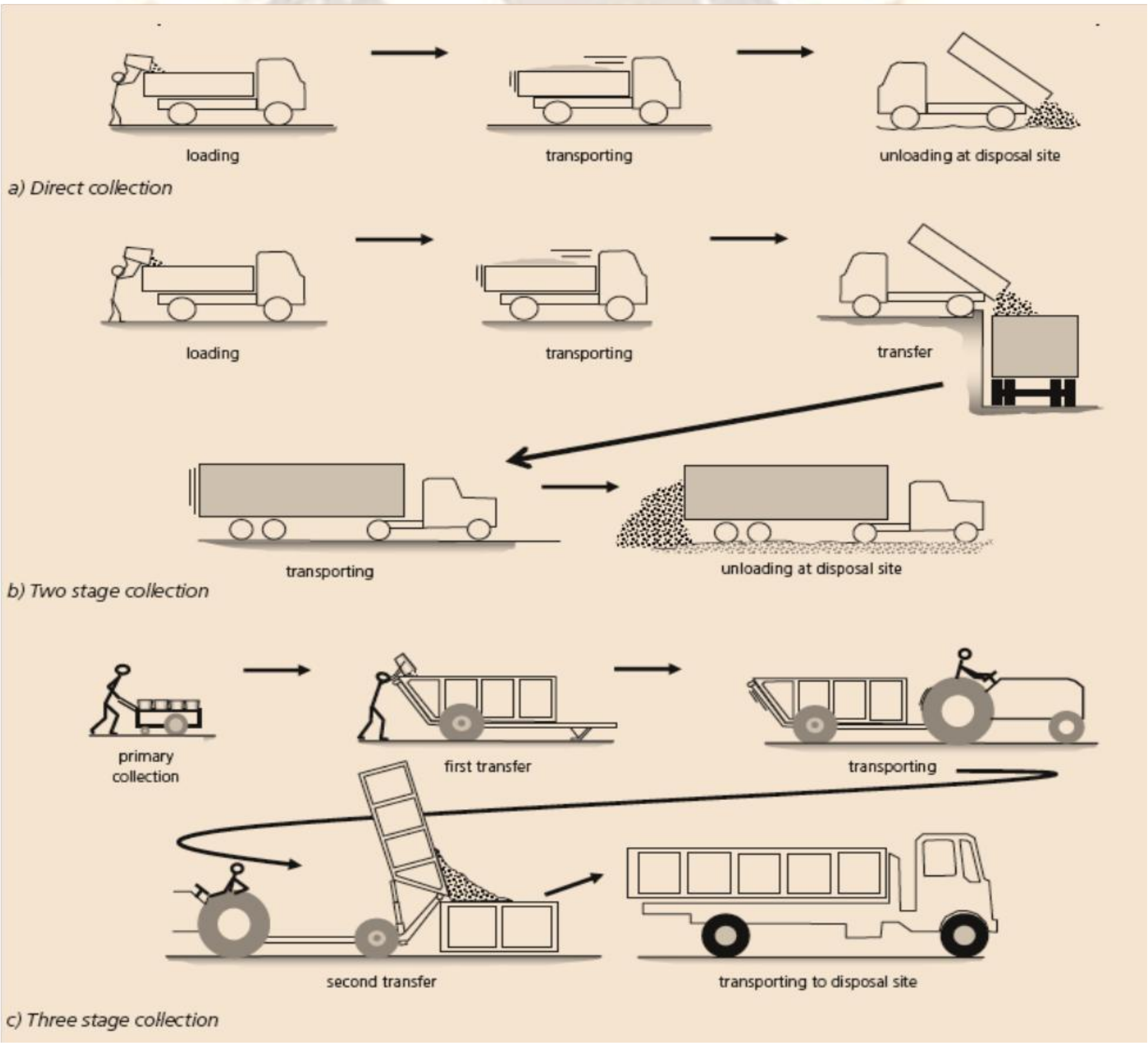

Figure 2 Collection of wastes
(Source: Collection of municipal solid waste in developing countries, UN-Habitat)

FLOW CHART

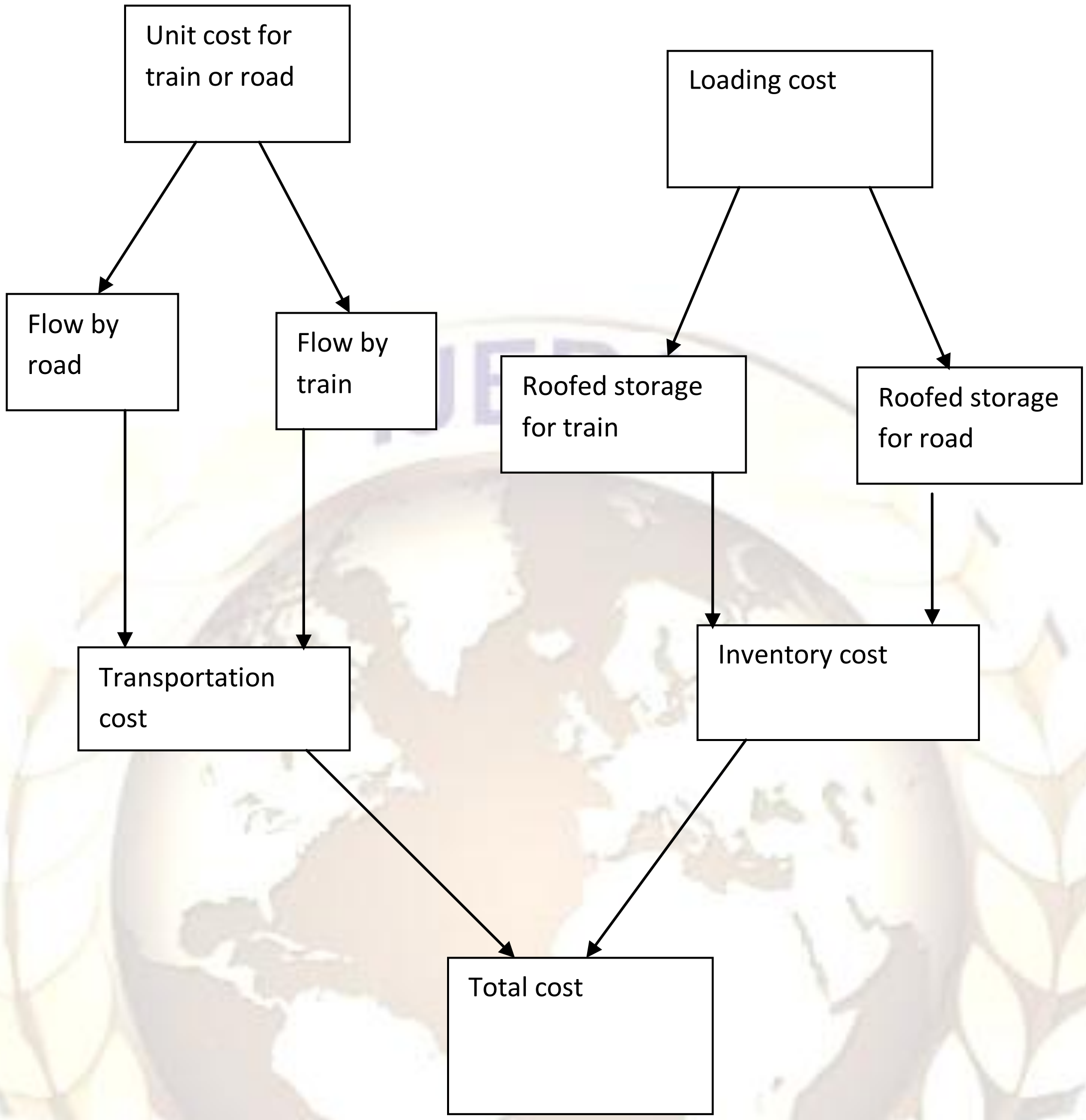

Figure 3 Transportation Flowchart

The figure 3 shows transportation flow chart, where the waste is transported by rail and road with storage facilities.

Notations for optimization

V - Storage volume
I - for inventory
D - Daily flow
U - Shortage quantity
O - Excess quantity
Ω - truck delay
Ψ - Train delay
G - Transportation use
H - Utilized regular transportation
J - Employment for regular transportation
P - Planned production
F - Flow
R - Regular transportation
Q - Irregular transportation flow rate

α - loading charge
β - Unloading charge
γ - Truck loading rate
η - Train loading rate
τ - Response time for irregular transportation
i - For products
j - For routes
l - For sites
p - Periods
E - Expectation
S - Standard deviation
a~ - For random
a^ - Estimated function
_ - Lower bound
¯ - Upper bound
B – Beginning
F – Final
φ – Strike factors
Y – Unit running cost of truck or train for one ton

LOGISTICS COST

Logistics cost creates a balance between cost and performance, since the lowest-cost transportation path is not necessarily the fastest(4). Logistics costs relate to the charges for various transportation methods, including train travel, trucks, air travel and ocean transport(7). Additional logistics costs include fuel, warehousing space, packaging, security, materials handling, tariffs and duties(8). It includes designing of supply chain using diagrams resembling flowcharts as shown in figure 3 that can simulate the supply chain. It aims to work through each phase of the goods' journey through the supply chain to calculate the time and related costs for various modes of the travel.

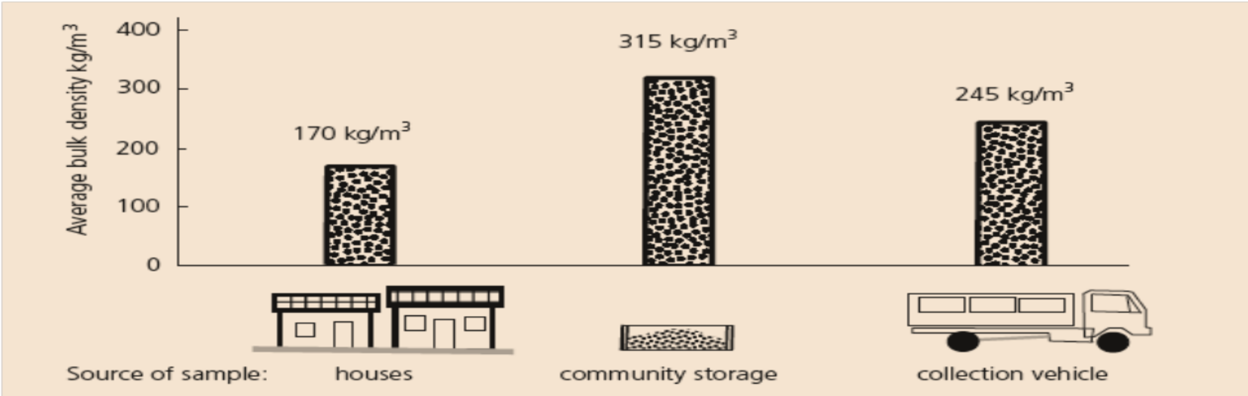

Figure 4: Variations of waste density between the household, in the community container and in the transfer vehicle for a typical situation.
(Source: Collection of municipal solid waste in developing countries, UN-Habitat)

Many waste collection systems use hydraulic compaction to increase the density of the waste in order to reduce vehicle and storage requirements, as shown in figure 4 Variations of waste density between the household, in the community container and in the transfer vehicle for a typical situation. It is therefore essential for the selection of any waste storage, collection and transfer system to use reliable information on both the weight of the wastes and the volume they occupy at the different stages between storage and final disposal.

In our research work the Optimized logistics cost equation is framed it helps to calculate the cost in a single equation, presented by CT(V) represents the total logistics cost for the total volume as shown in equation (1). The unit cost for each type of cost factor, multiplied by the rest to calculate the annual expected quantity, determines the components of the annual expected cost objective function. Let CI_{il} be the inventory holding cost from all sites(l) and all products (i), CU_i the shortage cost, as our logistic material is municipal waste the in the mixture is almost unwanted other material intervention can cause material shortage, CO_i the excess cost, this happens due to deviation from actual path, safeguarding material from climatic condition etc for (i) products at (p) periods. CG_{jp} the regular transportation cost for (j) routes and (p) periods,CJ_{jp} the irregular transportation cost for (j) routes and (p) periods it happens dues to unexpected route changes , CH_{jp} the cost of empty transportation for (j) routes and (p) periods empty transportation cost occurs due to empty travelling of vehicles to the destination points and Ω (i,l,p) includes truck delay for(i) products, for(l) sites, for (p) periods, φ (i,l,p) include strike factors for (i) products, for(l) sites, for (p) periods CW_{il} the cost of new roofed storage capacity for (i) products in (l) sites. Hence the expected annual cost is given by

$$CT(V) = \sum_{ilp} CI_{il} \times I_{ilp} + \sum_{ip} CU_i \times U_{ip} + \sum_{ip} CO_i \times O_{ip} + \sum_{jp} CG_{jp} \times G_{jp} + \sum_{jp} CJ_{jp} \times J_{jp}$$

$$+ \sum_{jp} CH_{jp} \times H_{jp} - \sum_{ilp}\left(\Omega_l \times \Omega_{ilp} + \sum_{ilp} \varphi_l \times \varphi_{ilp}\right) + \sum_{il} CW_{il} \times \left(V_{il} - \overline{V}_{il}\right)$$

--------------------------------(1)

CONCLUSION

- This research project identified is mapped logistically with ecological flows of waste within the Trivandrum and Tirunelveli region.
- The results of this research indicate various improvement and efforts in the region for waste recycling supply chain, optimum route for transportation have been identified.

- The results provide insights to the waste collecting, sorting, transportation and re-processing activities involved in the recycling of wastes with stabilizing the situation and answering the questions arising from the local authorities from the region.
- This research is valuable for specifically to analyses the environmental impacts and allows local authorities to understand the impacts of not just the waste collection scheme, but also the wider issues related to the design of a recycling logistics system.
- The research also answers the question about the environmental impacts of exporting a new idea of transportation of waste to other countries.
- The environmental benefits like land filling through waste are a great boon to the society.
- It provides logistics and transport research communities with further understanding the concept of recycling in logistics systems.

REFERENCES

1. Alvarex-Gil, M. J, Berrone, P, Jusillos, F. J. & Lado, N. (2007). Reverse logistics, stakeholders' influence, organizational slack, and managers' posture. *Journal of Business Research*, 60, 463-479.
2. Andel, T. (1997). Reverse logistics second chance for profit: Whether through refurbishment or recycling, companies are finding profit in return products. *Transportation and Distribution*, 38(7), 61-6.
3. Aras, N. & Aksen, D. (2008). Locating collection centers for distance and incentive dependent returns. *International Journal of Production Economics*, 111, p. 316-333
4. Blumberg, D. F. (1999). Strategic examination of reverse logistics and repair service requirements, needs, market size, and opportunities. *Journal of Business Logistics*, 20 (2), 141-59.
5. Dowlatshahi, S. (2000). Developing a theory of reverse logistics. *Interfaces*, 30 (3): 143-55.
6. Dwyer, W. O., Leeming, F., Cobern, M. K., Porter, B .E., & Jackson, J. M. (1993). Critical review of behavioral interventions to preserve the environment: Research since 1980. *Environment and Behavior*, 25 (3), 275-321.
7. Ferrer, G., J. Swaminathan. 2006. Managing new and remanufactured products. *Management Sci*. 52 15–26.
8.. Geyer, R., & Jackson, T. (2004). Supply loops and their constraints: The industrial ecology of recycling and reuse. *California Management Review*, 46 (2), 55-73.
9. Graves, S. C., “Safety Stocks in Manufacturing Systems,” *Journal of Manufacturing and Operations Management*, 1 (1988), 67-101.
10. Kumar, S. & Putnam, V. (2008). Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors. *International Journal of Production Economics*, 115, 305-315.
11. Schwartz, B. (2000). Reverse logistics strengthens supply chains. *Transportation and Distribution*, 21 (5), 95-101.
12. Uzsoy, R., Venkatachalam, G., 1998. Supply chain management for companies with product recovery and remanufacturing capability. *International Journal of Environmentally Conscious Design and Management* **7**, 59-72.