INCLUSION OF REVERSE LOGISTICS IN CLOSED-LOOP SUPPLY CHAIN NETWORKS FOR INCREASED VALUE

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Supply chain Strategic decisions are long-term but contain varying degrees of uncertainty. Many supply chain network procedures are static and do not allow flexibility to the degree required in modern business supply chains. Close communication between buyers and sellers is essential. Closed-loop supply chain networks improve long-term performance. In addition to traditional forward logistics factors, supply chain managers should consider distances for material travel, acceptable inventory levels, Production decisions, and supplier selection in both forward and reverse directions. The uncertainty of demand and supply contributes to challenges in designing supply chain networks.

Closed-loop supply chain networks combine strategic considerations and have become a field of investigation of current researchers Alqahtani & Gupta (2018).

The literature includes studies on forward and "*reverse*" supply chain logistics. In closed-loop networks adding reverse direction (logistics) product flows allows increased financial valuation. Reverse logistics involves moving products from suppliers backward in the supply chain to points where value is created (Sherafati & Bashiri, 2016).

Reverse logistics includes returning a product to manufacturers to create value for items that would otherwise have no value. Factors to consider in developing closed-loop supply chains include:

1. Components inside final assemblies often have longer useful lives than the assemblies that include the components.
2. Customers may have demands for spare parts, such as for repair.
3. Multimodal transport selection for forwarding movement might be different from reverse flow.
4. Various recovery and resale options are available in reverse directions.

Sherafati and Bashiri (2006) proposed a mathematical model to consider the factors in reverse logistics. The purpose of the model is to test a method using uncertainty levels to establish optimum network designs. The authors concluded that managers should attempt to lengthen supply chain capacity, add reverse logistics, improve profits, and create better customer service. Additionally, the flexibility built into models considering uncertainty allows better seller customer relations. The authors propose using closed-loop supply chain models to quantify uncertainty along with the forward and reverse logistic path.

Customer Service is better accomplished when initial designs consider the lifecycle, end-of-life condition. New technology allows designers to place devices inside products to monitor individual part's performance. Tracking the status of components facilitates better planning for handling assemblies and parts from repaired or returned products.

Reverse logistics plays a role in the final actions for the disposition of the material. When products are available for resale or reuse, the time from returning products to when products are available for resale or reuse is vital for good customer service. Modular replacement of assemblies occurs when devices in products predict the point of failure. Spare parts at

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distribution centers create fast cycle time support. Quick turnaround supports customers in a timely fashion.

Environmental concerns and green initiatives impact reverse logistics. For example, in traditional reverse logistics, optimizing value by selecting appropriate processing steps at various stages of earlier stages of production, the supply chain, is considered. Reverse logistics can also support green initiatives. For instance, adding costs for processing products considering environmental concerns can be added to existing reverse logistics value optimization models. The addition of cost factors provides better analysis and disposition decisions. Solving for dynamic lot-sizing is performed by applying green elements to existing models (Sbihi & Eglese, 2010). Variables in the model include: (a) options for no disposal of returns, (b) the costs of holding material to be serviced vs. costs of just keeping with no disposition, (c) elimination of variable cost considerations in the reprocessing effort.

Minimizing set-up and holding costs is the objective when the desire is to reduce the effect of adding green considerations to reverse logistics disposition decisions.

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