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Strategies and Modeling of Reverse Logistics Networks of an Industry in India

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ABSTRACT
Among the various aspects of SCM, emphasis has been placed on reverse logistics: closing the loop of a supply chain by integrating waste materials into logistic management decisions. Logistics network design is commonly recognized as a strategic supply chain issue of prime importance. While consumers traditionally dispose of products at the end of their life cycle, product take-back legislations introduced by governments shift this responsibility from consumers to manufacturers. As a result, manufacturers have to collect products at the end-of-life (EOL) and control their recovery or disposal. Product recovery, which encompasses reuse, remanufacturing and materials recycling, requires a structured reverse logistic network in order to collect products efficiently at the end of their life cycle. Meanwhile, ever growing concern for environmental problems and pressure from the global competitive marketplace toward further improvement of customer service, have been presenting industries with a new challenge; development and management of effective reverse logistics processes. The purpose of this paper is to present an overview to reverse logistics, and to provide insights on how to manage the creation of economically efficient EOL product returns and recycling practice in an Industry of India.

Keywords: Reverse Supply Chain. Recycling, Remanufacturing. End-of-life product, Closed-loop supply chain, Swot**.**

I. INTRODUCTION

Today, modern environmental management prescribes sustainable manufacturing practices that focus on prevention of waste and responsible care of the earth's natural resources. In particular, India is leading the way to reduce end-of-life of many house hold products like inverter batteries and packaging waste in its landfills by requiring manufacturers and distributors to "take-back" the environmentally hazards products and packaging for recycling or reuse. XYZ Limited is one of the Leading global business group of north India, operating as manufacturer and exporter of Lead Metal and its products. The company manufactures Lead Metal by Smelting and Re-cycling process, which is further extended to Lead Refining, Lead Alloying and Lead Oxide (Litharge, Red Lead & Lead Sub-Oxide). The group owns six Lead Smelting facilities in operation presently; out of which two are in Asia and Four in Africa. Other Four Smelting facilities are under erection in Africa and one is coming up in USA. Apart from Lead processing, XYZ Limited is engaged in Trading of Lead Scrap, Lead Ore, Lead Concentrates, Lead Battery Scrap and Lead Products Globally. Group also provides Technical Consultancy and execution on Turnkey Basis of Lead Smelting & Recycling Projects. The Company is managed by a team of professionals, having experience of more than 15 years of Lead Metal Industry and committed towards providing low cost Lead & Lead Products with highest level of quality.

Group believes in versatile services & ethical business practices by preservation and protection of our natural resources. Our operations are certified to ISO-9001 by BVQI (UKAS) and confirming to ISO-14000 guidelines. Company's 15 years experience of LEAD INDUSTRY has sharpened our expertise in producing the quality products such as Lead Metal and Lead by-products, which gives us an edge to garner the faith on qualitative ground.

The Refining Plant use pyrometallurgical process for Lead Refining, producing 5- 10 tons/ day Lead with a minimum purity level of 99.97% from furnace tapped crude lead.

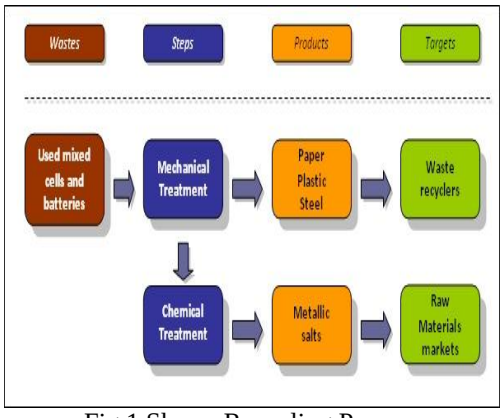

Fig 1 Shows Recycling Process

II. PROBLEM STATEMENT & OBJECTIVES

The present work studies the existing supply chain to find the key problem areas and proper analysis of the problem will be done to the industry with a proper validation.

The objective of the present project work includes:

- Identification of opportunities to improve the existing supply chain to make it agile.
- To develop a case study of battery manufacturing company of north India.
- To Design and develop a model of forward and reverse supply chain network of XYZ company.

III. REVERSE SUPPLY CHAIN

Supply chain is defined by The Council of Logistics Management as "the process of planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements." [4] However, a company's supply chain is not limited to delivering products to the end-consumers. Managers in many industries now realize that actions taken by one member of the supply chain can influence the profitability of all others in the supply chain.

The Council of Logistics Management defined reverse supply chain as "the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal." (See Figure1). To manage reverse supply chain, companies need sophisticated information systems. Some of the technology involved in reverse Supply chain is similar while in some areas the technology used differs from that of traditional supply chain.

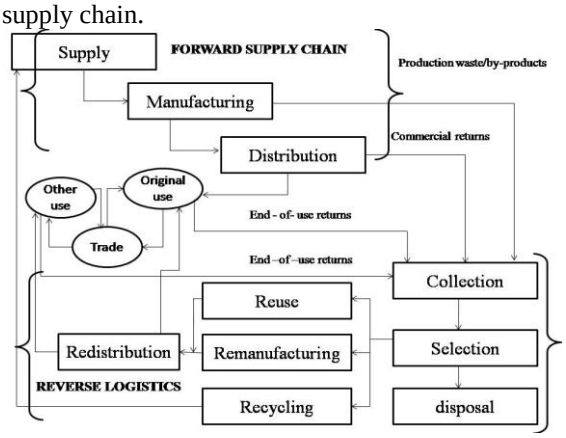

Fig 2: Logistics Networks in Supply Chain

IV. FRAME WORK OF REVERSE LOGISTICS

Reverse logistics is the collection and transportation of used products and packages. Lee et al [5] in Fig. 1 shows the framework of forward and reverse logistics. In forward logistics, suppliers offer raw materials to manufacturers. These manufacturers deliver finished products to distributors who finally distribute them to customers.

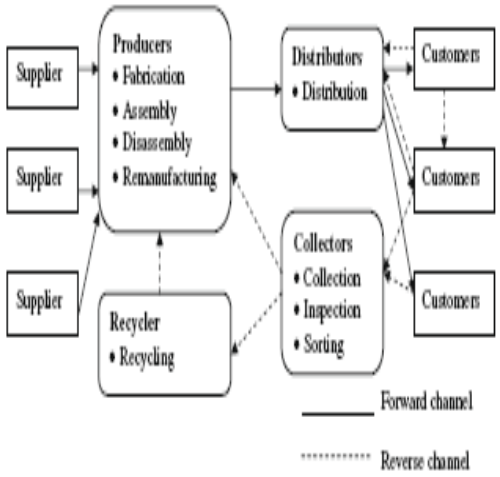

Fig. 1. Framework of forward and reverse logistics.

In reverse logistics, collectors and recyclers play important roles for reuse, recycle, remanufacturing and disposal. Reuse means that other customers directly reuse returned products in good condition. In the past, reuse involves in the process of extracting spare parts from original equipments and then reusing those parts for repair or maintenance. Nowadays, reuse is due to curiosity and vanity, and the emergence of e-bay helps prompt the culture of reuse. The physical property of recycled items was not changed (e.g. aluminum can) but nowadays recycle will change the physical property of return goods to new products. For example, the used wheel can be recycled to form construction material. Re-manufacturing is a series of steps including cleaning, disassembly, re-fabrication and re-assembly in order to transform a part or product to a new quality product. As returned goods may be made of hazardous material, special treatment is needed before disposal. Reducing in-transit inventory carry cost or minimizing the holding time and cost of collection points is necessary for forward and reverse logistics. For forward logistics, multi-echelon inventory is the main issue and bullwhip effect should be avoided by sharing information with different parties in the supply chain network. For reverse logistics, uncertain quantity and quality of returned products is the challenge faced by firms in reverse logistic

networks. In order to enhance the efficiency of recycling in reverse logistics, Lee et al [5] RFID is adopted to detect the quantities of return products so that efficient routing can be scheduled.

V. REVERSE LOGISTICS ACTIVITIES

There are many activities, which are involved, in reverse logistics; some of them are listed below in Table1.

Table 1: Common Reverse Logistics Activities

Materials	Reverse Logistics Activities
Products	Return to supplier Resell Remanufacturing Recycle
Packaging	Reuse Recycle Landfill

VI. CURRENT FORWARD & REVERSE SUPPLY CHAIN OF COMPANY

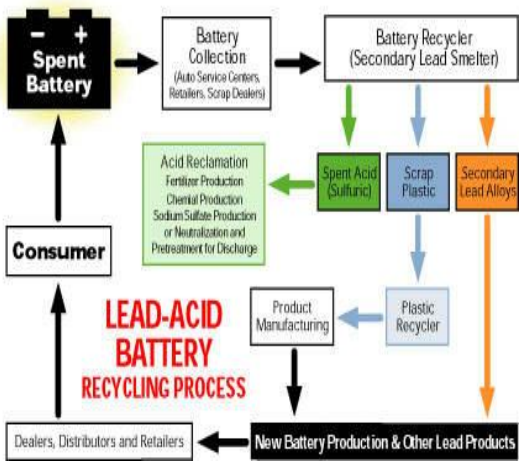

Fig4. FLOWCHARTS: Lead Acid Battery Recycling Process

VII. PROBLEMS WITH CURRENT RECYCLING MODEL

- Supply of used batteries is irregular.
- The company is not having any well-structured model of reverse logistics.
- Performance evaluation criteria's are not defined in the existing model of the company.
- Under utilization of existing workstations of the supply chain.

To Solve this kind of problems; we have developed an integrated model of the company, which is capable enough to predict the future performance of the company

VIII. PERFORMANCE PARAMETERS OF THE COMPANY

Table2 Different performance parameters of the company

	Distance (Km)	Speed (Km/hr)	Transfer Time (Min)	Transfer cost (Rs)
Council's	50	40	60	8
SBO's	50	40	70	8
Retailer's	32	45	42.5	6.4
Disassembly center	42	45	30.6	6.46

IX. DESIGN OF THE CONCEPTUAL MODEL

At the current stage, the company is not using a well define structured approach to get EOL product in the company. Therefore, we have designed and developed an integrated model of forward and reverse logistics supply chain networks. Prior to model Construction, it is first fundamental to obtain an appropriate conceptual model, by which the reverse logistics infrastructure can be described. When designing a network structure of reverse logistics, there are many factors to be considered .The factors include inverter batteries, the number and the type of participants in the system, battery collection centre, battery recyclers, consumers, characteristics of the material flow and product characteristics. The retailers will deliver the inverter battery directly to the disassembly centre. At the centre, the parts that can be manufactured or recycled will be extracted and transferred either to the recycling facility or to remanufacturing plant.

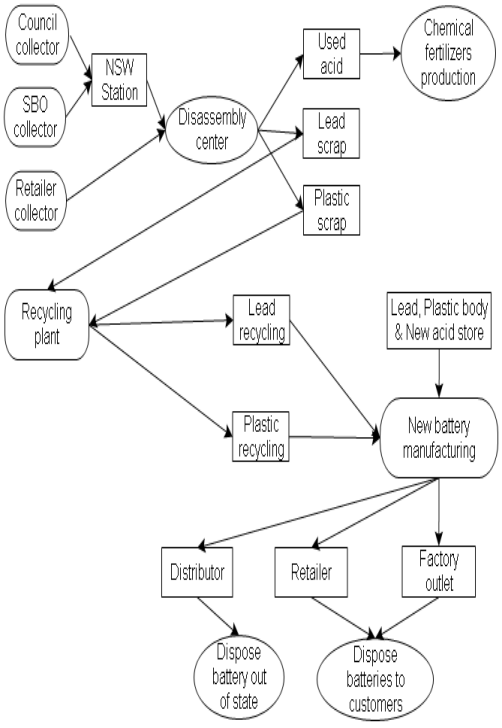

Fig 5 Proposed integrated model of forward & reverse supply chain network for battery recycling

X. SWOT ANALYSIS—BATTERY MANUFACTURER'S ABILITY TO MEET THE REQUIREMENTS OF WASTE BATTERIES

Strengths

- Take-back programs are viewed by customers to be a service if its easy to do or if its tied to consumer trade, purchase or part of municipal waste pickup service.
- Batteries can have a field life of 3–5 years, so predicting the rate of return and end-of-life value is not easily predictable.
- Few manufacturers have a robust reverse supply chain or information needed by dismantlers for efficient disassembly
- The technology used for recycling plastics is improving.
- Some parts are not used for disassembly.

Weaknesses

- Manufacturers have less control of consumer's disposal practices.
- There appears to be a shortage of profitable recycling outlets
- Economic profit has not been demonstrated for recycling or remanufacturing for many consumer products due to technological obsolescence, high labor for dismantling and lack of recycled material markets.
- The consumer demand for new technology may dissuade manufacturers and retailers from providing remanufactured products

Opportunities

- New market segments may be identified for remanufactured goods. Environmentally conscious design may add to ease of disassembly and refabrication into new products.
- Suppliers who can provide acceptable materials have market and profit growth opportunities
- The less effort needed to conduct end-of-life processing, the lower the cost of processing.
- Recyclability or remanufacture of components or products can be a key competitive advantage if disassembly can be optimized.
- New customer service offerings throughout a product's lifecycles or multiple life cycles could be differentiating and more profitable

Threats

- Waste collection centres (WCCs) will put pressure on their materials supply chain to accurately identify and remove hazardous substances. Supply chains may become disrupted.
- WCCs that cannot control or eliminate the hazardous materials in their products face fines and potential loss of markets in regulated countries.

XI. LIMITATIONS OF WORK

XYZ Ltd. company manufactures different types of batteries but we are considering only one type of battery i.e. invertors battery 150 AH (Amp. hour) for our work due to shortage of time and to reduce the complexity of the model. It can extend the scope of model to other products with some modification.

XII. SCOPES FOR FUTURE WORK

This study covers study of the complete supply chain of XYZ Ltd. more stress given to the user to analyze the future performance of the network and to understand the complex relationship between the parties involved. The XYZ Ltd. is one of the giant in the market of recycling sector. In this study the area in which the conceptual model can be implemented properly studied thoroughly and suitable conceptual model has been recommended to the company with proper validation. Moreover, the areas in which the company is facing problems have been studied and suggestions and models have been developed with the validation. Supply chain is a continuous process, it has to be modified to suit the new challenges faced by the company with the newer approach considering the advanced technology and market.

- The scope of work can be extended to improve the efficiency of distribution network by developing the efficient network by connecting the all distributors by the net.
- The model can be expanded to include the element of risk and uncertainty involved in the reverse logistics network design problem.
- The theme of future scope should include multi-objective treatments of the reverse logistics network design which explicitly analyze the tradeoffs among cost, response time, market potential, and speedy returns.
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XIII. CONCLUSIONS

The present work provides a flexible model to address some of the aforementioned problems associated with reverse logistics networks. In order to achieve a reverse logistics network was designed to establish transfer stations, drop-off points and a disassembly plant.

The model was tested for the spent battery collection process in the XYZ limited of northern India. The certainty of the results was statistically defined using a confidence interval of 95%. Following conclusions have been made from this project:

- An integrated network in view of forward and reverse supply chain logistics has been designed for the Battery manufacturing company which simulates to optimize the supply planning function.
- The principle of reverse logistics has provided the basis for this project, which investigates the take-back system for discarded spent batteries collected from the customers through different external suppliers such as councilors, SBOs, retailer and dis-assembler and transported to the recycling plant.
- Model of a reverse logistics networks for collecting EOL inverter batteries in the XYZ Limited Company, successfully represents dynamic processes of order arrivals, distribution center operations, and delivery transportation.
- SWOT analysis for the company has been prepared which was very beneficial for the industry.

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