

Applying Environmental Value Chain Analysis

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Abstract

Environmental Value Chain Analysis is based on the concepts of Customer Value Chain Analysis and Supply Chain Management. Customer Value Chains show the value relationships between different actors, with the ultimate goal of delivering the highest value product or service as perceived by the customer. Supply Chain Management seeks to optimize performance and costs associated with managing the systems of suppliers. Applied to environmental topics, Environmental Value Chain Analysis illustrates the relationships between the groups implementing environmental improvement programs.

In particular, this paper describes the application of EVCA to product end-of-life treatment programs. The analysis examines the information, money and product flows between players. The players of concern are the producers, government, consumers and recyclers. Within each of these groups, there are also internal value chains. The most critical of these turns out to be the producer's internal value chain, which represents the complexity of interaction between different business groups within a company.

Based on product characteristics, end-of-life treatment yields profit or deficit. If the end-of-life treatment yields profit, EVCA identifies further improvements in the processes or products; on the other hand, if the end-of-life treatment yields deficit, EVCA provides guidance in developing the best system. Case studies from Philips Medical Systems, Hewlett Packard, General Electric and Kodak, with end-of-life strategies categorized by deficit or profit, are used to demonstrate the EVCA method. The lessons learned from these cases will increase eco-efficiency of end-of-life treatment programs yet to be established. EVCA can help:

- Increase recycling collection rates (by understanding interactions with consumer);
- Improve logic of proposed legislation (by showing actors influencing decisions, by making transparent the complexity of proposed product and/or fee collection systems),
- Decrease recycling costs (by improving relationship between producer and recycler and by limiting extraneous players), and
- Organize value chains in such a way that the systems provide incentives for design for recycling

1 Introduction

Previous Design for Environment work has focused on technical improvements to products and processes. While these improvements, within the realm of control of producers, have led to significant reduction of environmental impact, there are substantial improvements possible only when including factors outside of the direct control of producers, including relationships with suppliers, consumers, recyclers and governmental authorities. As environmental challenges become increasingly demanding, all stakeholders must come together to achieve greater success.

2 Background

The realization that environment depends on business as well as technicalities resulted in the development of the Environmental Value Chain Analysis. Many times the environmental benefits perceived by the customers and other stakeholders are more important than scientific calculations of environmental gains. Customers continue to purchase and use products; therefore, being better than the competitors is more critical than striving to be the best in environmental care irrespective of the costs. Understanding the importance of communicating results is just as crucial as obtaining the results. Finally, realizing that top

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achievements can only be obtained when the entire chain is involved in the process.

This research is based on two current strategic management concepts – Customer Value Chain Analysis and Supply Chain Management. Supply Chain management seeks to optimize the supply of services and products to customers. Improvements to flow and supply of products and services to consumers have proved quite beneficial, both financially and image-wise. Unfortunately, to date, such techniques have only been used to streamline the relationships amongst producers of a product and the consumer of the product. In managing the entire supply chains, the chain is normally quite divergent with products being delivered around the world. The opposite is true in inverse supply chains where the products must be collected from a variety of sources. Work in so-called inverse supply chain is slowly gaining speed in the research field. Ideally, integration of forward supply chain with inverse supply chain flows would be most desirable, but is much more complicated. Purdue University is conducting ongoing research that seeks to develop supply chain models that include recovery of returned products, disassembly and remanufacturing [1].

Customer Value Chain Analysis seeks to identify pertinent customer and other stakeholders’ interests, their value perceptions and the relationship between these parties in green product or process development projects [2].

3 Environmental Value Chain Analysis applied to End-of-Life Systems

In searching for a more direct route of managing and communicating value, Environmental Value Chain Analysis is able to reduce complexity and cost of building programs for eco-efficient treatment of products at the end-of-life. The graphical representation of the EVCA provides clear demonstration of the actors participating.

Table 1. General Relationships between Players

Actors	Government	Consumers	Producers	Recyclers
Government	Political decision making	Votes! Taxes \$	Lobbying Taxes \$	Lobbying Taxes \$
Consumers	Representation, services	Feelings, Fads	Products Services	Used Products Services
Producers	Regulation, representation, services	Complaints Product, Pre-owned \$	Competition	Material \$ Recycled material
Recyclers	Regulation representation services	Products	Products Recycling cost \$	Competition

EVCA can be used to understand the relationships between the players: producers, consumers,

government and recyclers. The lines of jurisdiction, roles and responsibility are blurred within the groups themselves. A generic view of the relationships between government, producers, consumers and recyclers is shown in the following table. The next sections outline the participants individually.

3.1 Government

The elected officials in democracies have the ability to create legislation as well as to tax. The result is that those organizations that fail to comply with regulations are dealt fines or other penalties. Many levels within the government establish laws about environmental issues. For a simplified example, many levels in the US government establish legislation and regulations for environmental issues, starting from small to large scale: town, county, state, federal. In the US, the main environmental organization is the Environmental Protection Agency (EPA), although the individual state-level EPAs also can make legislation and choose the enforcement mechanism.

In the European Union, the Directorate General for Environment is responsible for take back and recycling regulation. However, in order to propose to the EU Council and the European Parliament, other Directorates General have to be consulted (the so-called inter-service consultation). The 15 member states have to be involved as well.

As one can imagine, having numerous organizations responsible for environmental legislation can get very complicated. The objectives for each of these environmental organizations should reflect concerns of the people they represent.

Depending on how end-of-life systems are set up, government could have a large or small role in the system. In the case of Kodak and Xerox, the end-of-life systems are not regulated or overseen by governmental organizations. On the other hand, the German packaging system (DSD) has in fact been prescribed through rules and targets set by the federal government.

3.2 Consumers

In the environmental playing field, the consumer wears several hats. Consumers have the crucial voice and the entire system revolves around their attitudes. Consumers vote for new political leaders, support products by purchasing and provide financial support to consumer groups to represent their views and feelings. Consumer behavior is a complex topic, but just briefly, research at Philips Consumer Electronics has shown there are seven distinct types of consumers when it comes to environmental issues [3]:

- Environmentally Engaged (E.E.)
- Environmental Optimists (E.O.)
- Disoriented Consumers (D.C.)

- Environment too Complicated (E.C.)
- Environmental Pessimists (E.P.)
- Growth Optimists (G.O.)
- Enjoy Life (E.L.)

This list shows a wide diversity of consumer behavior with respect to environmental issues.

In the end-of-life stage, consumers possess a product that no longer satisfies their needs, which they desire to dispose. This process can cause discomfort to the consumer if they are unable to get rid of the product or have to pay for its disposal. Seemingly inconsequential for a company, this inconvenience to the consumer could result in negative consequences to the company that has produced the product. Hence, it is more crucial from an image point of view for the company to place attention on the end-of-life stage rather than on environmental impacts of distribution, for example, a stage that has little ramifications on customer satisfaction.

3.3 Producers

The group of producers includes suppliers, manufacturers and assemblers of products. There are many other organizations that play roles in helping introduce products to the market including product management and development, marketing, sales, purchasing and logistics.

Increasing legal and consumer pressure pushes producers to develop voluntary take back systems. Producers must now start developing systems to bring their products back and recover value from them. As competitors take action, they will lose opportunities for advancing sales based on environmentally positive publicity.

Producers must work on their internal value chain to provide incentives for design improvements. Only through the internal support and systems will designers have specifications and metrics to improve designs. Economies of scale are necessary to deal with the cost issues as increasing pressure from other competitors requires that the end-of-life costs be lowered.

3.4 Recyclers

This group consists of the collectors, processors, and distributors of waste material, either disposing of waste or retrieving value from products and materials. Collection may be through retail or municipal infrastructure, may be through charitable donations, or may be through individual curbside pick-up. End-of-life processing options include repair, servicing, remanufacturing, recycling through shredding with or without disassembly and disposal through incineration or landfill. Recyclers have traditionally managed to minimize the costs and maximize the profits by selecting specific materials to recycle, hence their

focus has been on products that have high value such as gold, platinum, palladium, silver, copper, and even CFCs.

As more and more products are reaching the end-of-life, recyclers must operate on larger scales and must work longer hours to meet the demand of the products reaching obsolescence. In some markets, such as Europe, there has been excessive investment based on expectations for the future.

3.5 Others

Other players of relevance in the end-of-life system are distributors, retailers and pre-processors of waste. The first two members provide direct links between the customers and producers. An example pre-processor is photo-finishers in the case of one-time-use cameras, which provide a link between customers and recyclers. They are successful because they provide a service to the customer, which yields impetus for the customer to return the product.

These groups have little motivation to participate in product end-of-life treatment. Retailers make profit by having new products on their shelves or in storage, not by storing old products that have been returned from the customer. Hence, retailers generally have been very reluctant to participate in end-of-life systems. The same holds true for distributors whose profits are linked to storage and transport of new products, rather than returned products. Photo processors, in the case of Kodak, do receive reimbursement for each camera assembly returned to Kodak, approximately 13% of savings Kodak realizes. For retailers and distributors incentive systems, like the photo processor case, must be established to change their mindset if end-of-life systems are intended to include them as a link. An incentive is provided in the Netherlands, retailers are paid 2 NLG (\$0.75) for handling old televisions.

3.6 General form of EVCA

The following figure demonstrates an external EVCA applied generally to the relationships among producers, consumers, recyclers and government. EVCA can also be applied internally, as shown in the examination of Philips Consumer Electronics [4].

This diagram demonstrates the various types of flows between the players, focusing on information, product and money. The entire life of the product is examined -- from the producers, to the consumers and lastly to the recycling companies. In most cases these will come in pairs, but not always. It is important to distinguish the information flows as complaints, information exchange, top-down information and feedback. Complaints, sadly the most frequent, comes from dissatisfaction with communication, service, product or information provided. Appropriate

exchange of information leads to mutual benefit of the participants. Top-down information is a limited transfer of information from a 'high' member of the chain to lower members of the chain (depending on the 'power' in the chain). Top-down usually offers information as the higher member requires. Feedback is the response of lower members to these requirements or to other requests.

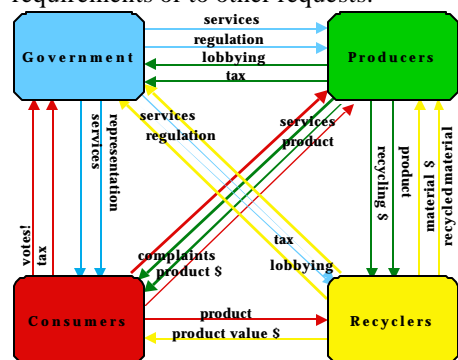


Figure 1. Example of External Environmental Value Chain Analysis

It is necessary to know the individual goals of the players regarding the end-of-life treatments of products – whether to minimize waste, make profits, improve customer and shareholder perception or to abide by regulation. It is also helpful to understand the goals and objectives of the other members. Awareness of the, often conflicting, goals and objectives allows for the appropriate values to be placed on the EVCA diagram.

EVCA looks different depending on the reasons for initiating the end-of-life system and end-of-life strategy. An end-of-life system focused on the end-of-life strategy – product reuse – looks different from one aiming to achieve high percentages of material recycling – product recycling through disassembly and without disassembly, leads to different relationships as well. The results of Environmental Value Chain Analysis (EVCA) allow decision makers to identify the critical success factors of such programs upfront.

Money and product flows must coincide for the end-of-life system to function optimally. End-of-life systems operating on voluntary returns have limited success, while end-of-life systems offering money in forms of credit provide appropriate incentives for consumers to return their products.

4 Application to Actual End-of-Life Systems

The case studies reveal that, apart from technical and economical factors, organization factors and external perceptions play a major role in the success of Ecodesign activities. The following sections describe

case studies analyzed using the EVCA method. The product end-of-life systems examined are representative of existing systems.

These case studies serve two purposes:

- 1) demonstrate currently implemented end-of-life systems
- 2) demonstrate Environmental Value Chain Analysis, showing areas of improvement in end-of-life systems

These diagrams also reveal gaps in communication between partners. The differences and similarities in these diagrams are compared to evaluate which methods have been most successful from the standpoint of all four participants. These examples are simplified for this paper, and are only the tip of the iceberg. The process of gathering the information is more crucial than the final picture reveals. Only with the final picture can the players sit down on an even playing field to work together to simplify and optimize end-of-life treatment systems to a win for all players.

Other programs have been established by individual businesses independent of other firms operating in the same industry. These programs include: Nike's Reuse-A-Shoe program; IBM, Dell and Hewlett Packard's computer-recovery programs; Hewlett-Packard's printer toner cartridge return program; several brand-name clothing return programs; a number of returnable transport packaging programs; and Saturn's bumper fascia return program [5].

There are several differences between private and institutional consumers. Private consumers typically make purchases in small volumes and small monetary amounts. On the other hand, institutional consumers make large purchases with contracts associated with the high volumes and monetary values. The differences between institutional and private consumers are exacerbated at the end-of-life phase.

4.1 Private Consumers

Kodak has developed an extensive remanufacturing organization for their single use cameras, remanufacturing over 60% of the product world wide [6]. The cameras are designed so that the consumers will not discard them; instead they return the entire camera to a photofinisher for developing. After removing the film for processing, photofinishers are encouraged to return the cameras to Kodak for recycling and reuse, reimbursing them for each camera returned and pays the shipping costs. The company reported that more than 80 million one-time-use cameras had been recycled and/or reused, representing a 77 percent recycling rate, exceeding recycling rates for both aluminum cans and soft drink bottles. A total of 26 of the 27 (96.3%) parts that make up Kodak's single-use camera are either recycled or reused in a new camera (some components are reused up to 8 times).

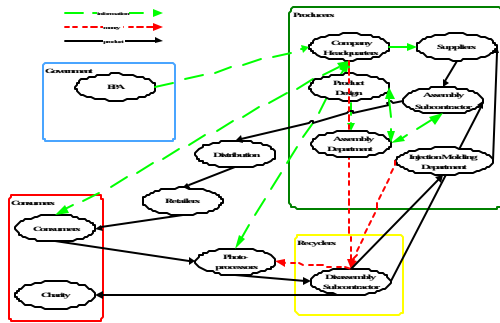


Fig. 1 Kodak single use cameras

Hewlett Packard sells a wide variety of information technology equipment from computers, servers to printers.

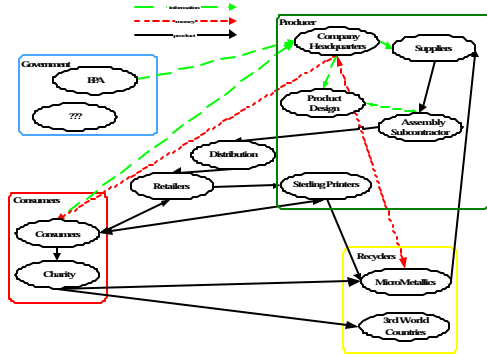


Fig. 2 HP printers

The Hewlett Packard and Micro Metallics partnership between an original equipment manufacturer and a recycling company recovers service parts and recycles useful materials from end-of-life products [7]. HP realizes great savings to the company by collecting products to harvest for service parts. As of yet, they have had limited success in reuse, or reselling their products on the market. To provide incentives for consumers to return their product, HP has started a program, Trade-in Trade-Up, that gives trade-in value to apply towards the purchase of new products [8].

Along with many other original equipment manufacturers, Philips participates in the mandatory take-back system in place in the Netherlands since 1999. The products are collected through the retailers and municipalities, then processed by existing recyclers.

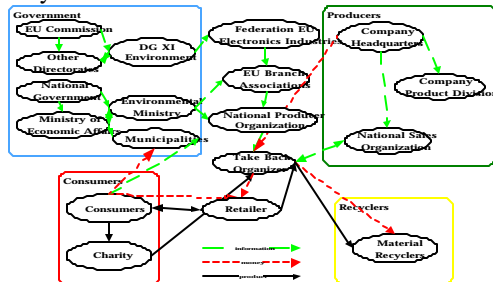


Fig. 3 Philips consumer products (TV)

The recycling costs are offset by fees paid by consumers at the purchase of new products and by the original equipment manufacturers.

4.1.2 Institutional Consumers

General Electric provides aircraft engines for military and commercial applications. They also include an extensive service contract through the life of the product, in which service is performed by another organization in the company. The long life of the product as well as the high value of materials at the final disposition allow for high reuse, refurbishment and recycling of this product. The incentives are inherent to the product characteristics. The largest challenge for GE is staying informed on changing regulations regarding fuel efficiency and usage conditions.

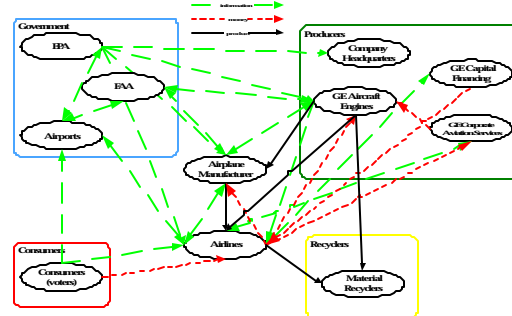


Fig. 4 GE aircraft engines

Philips Medical Systems refurbishes and resells their medical equipment, from ultrasound equipment to MRI equipment. The competition with brokers over sales and returns is a large challenge to increasing their market position. Some consumers perceive the reliability is lower, although both new and refurbished must pass exact certification procedures.

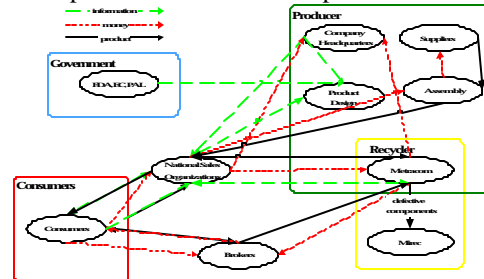


Fig. 5 Philips Medical Systems

5 Implications on Decision Makers

The examination of the product end-of-life systems shows weak lines of communication, demonstrating relationships that may be neglected. In some cases, there are redundant mechanisms for collecting products, leading to confusion from consumers and

increasing end-of-life costs. Where products have perceived end-of-life value, through materials or application, the incentives for product return exist naturally. The use of EVCA shows the incentives, such as service to the consumer or trade-in value. On the other hand, if consumers are burdened with additional fees, such as the Dutch take back system, there are many disincentives for consumers.

The learnings or recommendations from the EVCA can be divided into three categories – product, information and money. By understanding these three crucial flows, decision makers such as product designers and managers, recycling organizers and policy makers can improve the current end-of-life systems.

First, understanding that product characteristics heavily influence what is possible at the product end-of-life. It must be recognized that how the products are sold and managed through the life of the product also influences the company's mechanisms, whether the consumers are private or institutional.

Secondly, recognizing that fee systems must be decided and agreed on by all participants in the end-of-life systems is necessary. For example, fee systems that place heavy burdens on one group will not be successful. Incentives are more successful, through trade-in or rebate systems, and will encourage more participation. On the one hand, it is remarkable that the new legislation prevents products from being incorrectly disposed. However, the current fee systems in place in the legislation mandated end-of-life systems are incorrectly structured. The existing fee structure charges producers equally, even if some products are cheaper to recycle. Therefore, there is no reward for companies that have products which have undergone extensive redesign to reduce the end-of-life treatment cost. Additionally, the department charged for the end-of-life costs does not always transfer those charges to the design departments. Therefore, there is no incentive from a design perspective to improve the end-of-life treatment costs. If the financial mechanism involved in these end-of-life systems does not involve the design departments, then the objective to encourage ecodesign is not achieved.

Last, realizing that the flow of information and value perception is crucial for improving coordination of end-of-life systems. Mandates or the typical top-down approach has not proven successful and only through increased exchange and mutual understanding can costs be minimized.

6 Conclusions

EVCA proves that making simple diagrams showing the flow of money, products, and information in the proposed end-of-life systems can reduce end-of-life treatment costs and improve end-of-life treatment profits. Comparison of the existing systems with potential systems can reduce the need for pilot programs and increase the success of current programs.

7 Acknowledgements

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