Green Initiatives as a Key Solution to Turn a Supply Chain into a Value Chain: An Empirical Study of a Small Enterprise in China

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Abstract This paper highlights the need for a shift in the manufacturing process of plastic bags integrating green actions to promote environmental concerns within the supply chain. In fact we believe that there is no value added within the supply chain if green action is not considered. The paper based on empirical figures develops a cost analysis method over a two year period to demonstrate that the implementation of green actions to create value to the product within the supply chain is achievable and affordable even for a small enterprise in China. A comparison between different manufacturing processes, those without green actions and those integrating green initiatives, has led to the conclusion that green initiatives, here the adoption of a recycling system generate favorable environmental and financial performances. The cumulative costs of different production system confirm that the implementation of green action is profitable in the long term and constitute therefore a way of creating real value into the supply chain.
Key words value chain, supply chain, green initiatives, small Chinese enterprise

1 Introduction

Since Michael Porter woks on value chain analysis, published in his best seller "Competitive Advantage: Creating and Sustaining Superior Performance"[1], companies' decisions makers have been constrained to re-examine their supply chain with the aim of identifying possibilities of creating more value at each level of the chain while working to achieve the company's objective. Strategies at the corporate level as well as at the functional level have been conceived and implemented in order to improve the manufacturing process. This has led to value maximizing and cost reducing strategies that are applied from the product design stage to the final output, including the delivering to customers. However since the global alarm on the climate change, environmental issues are becoming a top of mind concerns for firms. Strategic initiatives taken to create value alongside the supply chain reveal to be environmentally harmful. Actions and useful inventions aimed to better the product cause many adjacent problems which touch many aspects of the life. Understandably that the world Report on the human development 2001 declares with accuracy: "Any technological progress is accompanied by advantages and potential risks, which are not inevitably easy to anticipate"[2]. Therefore it is necessary to redefine "the value chain" concept. The green supply chain provides an opportunity to review the manufacturing process, materials and operational concepts.

Our analysis aims to demonstrate that all value chain initiatives are not really value chain creation (activities) when environmental considerations are not taken into consideration. We also aim to use information from the market to assess the investment cost of different production systems and the production cost of different manufacturing processes.

2 Data and Methodology

To reach these objectives, the paper uses logical reasoning based on known definitions of the concept into research. Then practical figures computed from basic information gathered from factories all around China are applied to a small factory to constitute a model susceptible to be followed. The findings are variables that lead to the conclusion and support the implementation of green actions. Finally, innovative suggestions to create genuine value that complies with today's environmental requirement are made at the corporate level where conceptual decisions are made as well as at the functional level where tactical decisions are prepared for implementation.

2.1 Value Chain Concept

Philip Kotler, considering a firm as a collection of activities, defines the value chain as activities that create value and cost in a specific business[3]. Pearce and Robinson writing on Strategic Management, point out that "the term value chain describes a way of looking at a business as a chain of activities that transform inputs into outputs that customer's value. Customer value derives from three

basic sources: activities that differentiate the product, activities that lower its cost, and activities that meet customer's need quickly"[4]. From several researchers, value chain disaggregates the business into series of activities starting from the raw material procurement to the after sale service provided to the final user. At each level of the series, search for low cost strategies is performed and attributes that differentiate the product are identified for more value added. Executives are always running after strategies that turn the supply chain into value chain. However this urge toward the product differentiation and customer satisfaction might have destructive implication if environmental concerns are not considered.

2.2 Supply Chain Concept

The supply chain is defined as "the system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer[5]."

From this definition, the supply chain often includes more than one company in a series of supplier-customer relationships. It is series of links and shared processes that involve all activities from the acquisition of raw materials to the delivery of finished goods to the end consumer. Raw materials enter into a manufacturing organization via a supply system and are transformed into finished goods. The finished goods are then supplied to customers through a distribution system.

According to the value chain concept, companies, linked together in this process, each adds value to the product as it moves through the supply chain. But if no explanation is given as what "value' really involves, the ultimate goal may be lost, meaning that the whole chain might urge to create value while deteriorating the product in term of harmful substances or damage to the environment. To illustrate this viewpoint, we will consider the graph below for analysis.

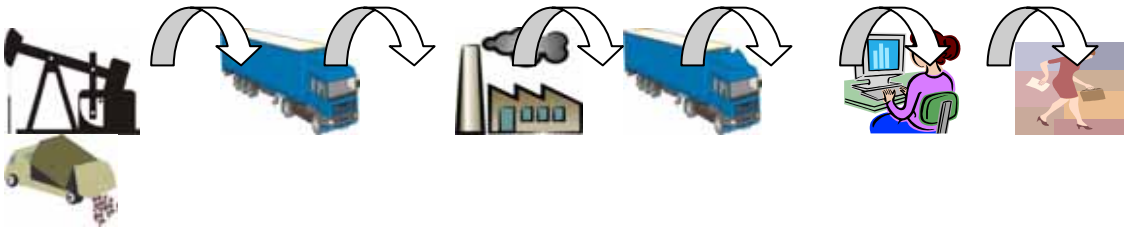

Figure 1 Supply Chain Activities

Source: Adapted from "LMI, Best Practices in Implementing Green Supply Chains, April 5th, 2005,8

Firms within the chain agree closely on what steps to be implemented to create the genuine value to the product. But, considering the process above, at the raw material extraction level, water and energy are parts of the input but the process unfortunately has impact on the environment in terms of gas emission, waste water and discharge. The transportation system is still source of air pollution contributing to smog, acid rain, greenhouse gases and climate change; in the factory, depending on the product and the manufacturing method, impact on air, water and waste is noticed; likewise at the retailer level depending on the distribution system, the retailer may generate only waste. Then, at the final step which is the consumption of the product by the customer, waste in terms of discharge is inevitably. For example for plastic product, such as plastic bags, waste often becomes litter. Obviously the impact can be apprehended at different level of the chain

Thus actions initiated by companies within the chain to create value to the product must definitely include environmental concerns to be considered as "real value". This implies strategies that promote reduction of waste and lower impact on air and water; actions that promotes energy conservation and reduces all negative externalities within the supply chain. From this standpoint the green supply chain is what really integrates the value concept within the chain for it identifies the waste streams, measure the opportunity cost of the waste and create innovation through waste reduction process. The green supply chain is "… the fully-integrated, extended supply chain with all the elements of the traditional supply chain plus the one-way chain to construct a semi-closed loop that includes product and packaging recycling, re-use, and/or remanufacturing operations…"[6]. The concept of green brings to the formal structure of a supply chain an additional process that provides an opportunity to review processes, materials, and operational concepts. So re-use, recycle and remanufacture are being incorporated to improve the chain and therefore create a competitive value chain. Implementation of green supply chain

is achievable and affordable even for a small enterprise. For our article, a case study is based on the plastic bag industry in China.

2.3 Green Initiative within a Small Factory

Small enterprises have been playing an important role in the Chinese economy. They are backbone of China's economic growth and the major contributor to newly created employment. Statistics from the China Association of Small and Medium Enterprises showed that the nation had over 4.3 million registered small-and medium-sized enterprises. They contributed 59 percent of China's gross domestic product (GDP) and employed 75 percent of the nation's labor force by the end of 2006[7]. However these small enterprises do not have easy access to capital, technologies and information compared with larger enterprises. Given an opportunity, we believe that small firms can sensibly contribute to better the pollution level which is actually generating health and environmental problems in China. Our choice goes to the plastic industry. Our objective is to demonstrate how innovative strategies can be adopted and investment made toward a green production system even within a small as far as plastic bags are concerned

2.4 Plastic Bag Manufacturing Process

The world's consumption of plastics keeps increasing. From 5 million tons in the 1950's, the actual consumption is estimated to 100 million tones, that is 20 times more. But its production is very polluting (emission, energy, waste) since it requires resources that are fossil fuels. Besides the raw material and energy for the manufacturing process, chemical products added as stabilizers and colorants are harmful to human health and to the environment. Moreover the disposal has a significant impact on the environment since it is non-degradable; plastic waste very often turns to become litter. This understanding brings us, to consider alternatives that lower the impact by the adoption of new technologies.

The raw material necessary to manufacture plastic bags is the granulated polyethylene which is a thermoplastic commodity heavily used in consumer products (notably the plastic shopping bag). Over 60 million tons of the materials are produced worldwide every year. The polyethylene pellets are heated at a temperature of 200 degree in order to obtain a paste, mixed in a screw of extrusion and pushed in an annular die.

One thus obtains a matter tube which is inflated by an airstream in order to become a cylindrical bubble several meters height, which is then flattened and rolled up continuation. A roller is realized which will be then cut out of bags of various lengths, folded and put out of paperboard. Control is permanent during all the process.

2.5 Investment

Assuming that facilities are available, four types of basic machines are necessary to produce the plastic bag:

- Plastic grinding Milling Granulator
- Mixer, where granulate and colorants are mixed.
- High Speed film blowing machine
- Sealing and Cutting bag maker

The folding and printing machine bring another level to the investment

2.6 Cost Estimates

The analysis is done in terms of plastic machinery investment cost and production cost. Then the total cost is cumulated within a period of two years to measure in some ways the feasibility and the affordability as well. This information could help calculate the return on investment if the selling price is known.

2.7 Machinery Investment Cost

The first estimate is about plastic bag factory using virgin polyethylene as raw material. All the information given below about prices and performance use are from factories[8]; and prices are in Chinese Yuan (Rmb).

The printing and folding machine are considered secondary.

Table 1 Machines SellingPrice and Performance Use Information

Machine	Price (RMB)	Power (kw)	Capacity(kg/h)	Working time h/jr
Grinder	34000	15	180 m3	
Mixer	5440	1.1		
Film blowing machine	56000	12	22	24
Sealing and cutting machine	64170	1.1		
Waste plastic film granulator	56000	22	100	5.2

Source: Jiangsu Jiang Yin Guibao Rubber and Plastci Co.Ltd and Zhejiang Ji and machinery Co. Ltd

With the total amount of 159610 Yuan or 23472 dollars, one can invest into the plastic manufacturing by acquiring the needed machines. And 181610 Yuan which is equivalent to 26707.35 dollars are the amount necessary to set up a factory with a recycling system.

At first glance, the second investment might seem higher than the first but our analysis is going to integrate the production cost now then the over whole cost involved within two year exploitation.

2.8 Production Cost

To calculate the production cost, we focus on the cost of raw material acquisition and the variable cost associated to the production; the human labor cost is not taken into consideration.

The market information available is:

1 kw = 0.6 Yuan

1 ton of granulate of polyethylene = 6000 Yuan

1 ton of biodegradable material = 13000 Yuan

I ton input of raw material = 125000 sac plastic

The cost of recycle polyethylene is quite difficult to estimate but for each material recycle there is a loss of 2% to 15 % depending on the fact that the recycling polyethylene is of higher quality or lower quality.

2.9 Production Cost Associated to the Manufacturing Process without a Recycling System

The machines involved are grinder to crush waste thread sometimes, mixer, film blowing machine and the cutting machine. The grinder could not be indispensable.

Cost associated to the film blowing machine

Knowing that the capacity is 22kg/h and the working time is 8x3 according to the Chinese rotation system,

Capacity T/ Jr = (22x24) x 0.001 = 0,528 T/j

The consumption in term of electricity = 12kw x 24 = 288kw

The electricity price = 288 x 0, 6 = 172, 8 Yuan

With the daily capacity of 0,528 T and knowing that 1 ton of raw material generate 125000 plastic, we understand that 528 kg would mean 66000 (125000 x 0,528) plastics daily so for one month, i.e. 20 working days, the production would be of 132000 (66000 x 20). This quantity of output corresponds to

$\frac{132000}{125000}$ = 10, 56 ton of input

Coast associated to the grinding machine

Acquisition cost = 34000 Yuan

Consumption =15Kw. 24 = 360 kw ;

Electricity fee = 360x0.6 = 216 Yuan

Cost associated to the mixer

Acquisition cost: 5440 Yuan

Power consumption: 1.1x24 = 26Kw

The electricity fee is 26.4x0.6 = 15.84 Yuan; the monthly cost is 316.8 Yuan

Cost associated to the cutting machine

Acquisition cost: 64170Yuan

Power consumption: 1.1x24 = 26Kw

The electricity fee is 26.4x0.6 = 15.84 Yuan; the monthly cost is 316.8 Yuan

Then the monthly cost is an addition of raw material +electricity fee + machine cost

Raw material cost = 10,56T x 6000 = 63360 Yuan

Electricity fee = (172,8 x20) + (15,84 x 20) +(15.84x20)= 4089.6 Yuan

Machine acquisition = 5440+56000+64170 = 125610 Yuan

The production cost associated the recycling process system

Here the waste plastic film granulator machine is the one that transform the waste into granulate of polyethylene but as we mentioned earlier, there is definitely a percentage of loss.

So to obtain 524 kg of raw material as required the manufacture, we need to transform

$$0{,}528 \text{ x } \left\{1+\left[1-\left(\frac{0.98+0.85}{2}\right)\right]\right\} = 0.573 \text{ T}$$

To calculate the daily production capacity, we use the 573 kg, that is

$$\left[0.573\left(\frac{0.98+0.85}{2}\right)\right] = 0.524 \text{ T}$$

The working time by hour is $\frac{0.524x1000}{100}$ = 5.24 h which implies that

The consumption = 22x5.24 = 115.28 Kw

The electricity price is 115.28x0.6= 69.16 Yuan

The monthly cost is

The cost of the mixer and cutting machine is in term of power consumption: 1.1x24 = 26Kw

The electricity fee is 26.4x0.6 = 15.84 Yuan; the monthly cost is 316.8 Yuan

Table 2 Machine Cost and Production Cost

Machine	Price rmb	Power KW	consumption	Electricity. 24h	capacity kg/h	Hours	capacity T/J
Recycling machine	56000	22	115,32	69,19	100	5,2	0,524
Grinder	34000	15			3m3/min	24	
Plastic making machine	56000	12	288	172,8	22	24	0,528
Mixer	5440	1.1	26,4	15,84		24	
Cutting machine	64170	1,1	26,4	15,84		24	

2.10 Computing the Total Cost

To grasp the total cost and assess the value of different production process, an analysis is made over a 2 year period through cumulative costs. Here below, the summarizing table.

Table 3 Cumulative Costs of Machine Acquisition and Operating Cost

Month	No recycling system	Recycling system	Recycled 50/50	Recycled 30/70	Recycled 70/30
1st month	193060	250443	250443	250443	250443
2nd month	260509	255917	286905	299300	274510
3rd month	327959	261390	292378	304774	279983
4th month	395408	266864	297852	310247	285457
5th month	462858	272337	303325	315721	290930
6th month	530308	277811	308799	321194	296404
7th month	597757	283284	314272	326667	301877
8th month	665207	288758	319746	332141	307350
9th month	732656	294231	325219	337614	312824
10th month	800106	299704	330693	343088	318297
11th month	867556	305178	336166	348561	323771
12th month	935005	310651	341639	354035	329244
13th month	1002455	316125	347113	359508	334718
14th moth	1069904	321598	352586	364982	340191

15th month	1137354	327072	358060	370455	345665
16th month	1204804	332545	363533	375928	351138
17th month	1272253	338019	369007	381402	356611
18th month	1339703	343492	374480	386875	362085
19th month	1407152	348966	379954	392349	367558
20th month	1474602	354439	385427	397822	373032
21st month	1542052	359912	390901	403296	378505
22nd month	1609501	365386	396374	408769	383979
23rd month	1676951	370859	401847	414243	389452
24th month	1744400	376333	407321	419716	394926

When we look at the table, it seems like the recycling system is cost but in a long term perspective, the recycling system strategy is cost reducing. The graph below is helpful as for assessing the long term perspective of the recycling system.

3 Results

Over 2 year production, the manufacturing process with virgin polyethylene appears to be excessively costly compared to other system integrating the recycled polyethylene. It would be rational for managers to consider alternatives that are profitable in the long run instead of being short sighted.

Information provided by the market shows that the investment on a recycling plastic bag manufacturing is affordable and achievable. Though the machine acquisition might seem higher since an extra recycling machine must be added compared to the normal manufacturing system, generated profit in times procure higher benefit. In fact, integrating the recycling system gives to the factory the possibility of becoming its self supplier if it can organize the collection of waste. If not, the factory can still acquire the waste from specialized agencies in lower cost than the virgin polyethylene. Besides except for the first month where the traditional system may seem better in term of cost, the following month shows a better perspective with the recycling system. Other alternatives are also available to lower the loss in quality noticed in 100 % recycling system. Combined system made of mixed raw material, virgin polyethylene and recycled one, also shows lower production cost in the long run.

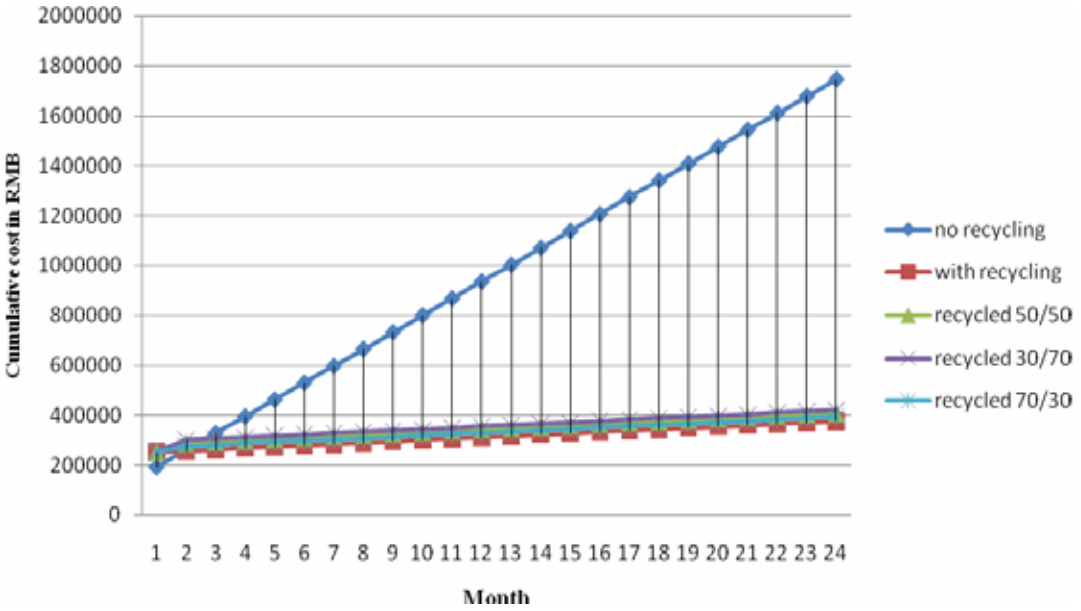

Figure 2 Cumulative Cost of Different Production System

4 Conclusions

In this paper, we have analyzed the possibility of turning the supply chain into a value chain by adopting green initiatives. To concretize our analysis, information from the market have been studied to assess the feasibility of a plastic bag manufacturing investment project that integrate green practices through a recycling based system of waste. Results have shown that though this investment might be higher in term of machine acquisition, the operating cost over two year period shows significant benefit of a recycled based system. In fact 159610 Yuan or 23472 dollars are required to set up a traditional plastic bag factory based on virgin polyethylene as raw material while the recycled based manufacturing system requires 181610 Yuan which is equivalent to 26707.35 dollars. However the operating cost from the second month shows significant advantages. With a beginning of 193060 Yuan for a no recycling system, 250443 Yuan for a recycling system, 250443 Yuan for a 50/50 recycled system, a lower cost is noticed already by the second month; 260509 for a no recycling system, 255917 Yuan for a recycling system, 286905 Yuan for a recycled 50/50 system, 299300 Yuan for a recycled 30/70 system and 274510 Yuan for a recycled 70/30 system. Moreover besides the financial profit, the production system based o recycling practice along the chain optimize the manufacturing process, decrease the pollution load caused by virgin materials, protect the environment since it emit less greenhouse gases and preserve the natural resources. It is admitted that one ton of plastic bags saves 7.4 cubic yards of land fill space.

Thus innovating by the adoption of a production system that integrates the recycling of waste offers a competitive advantage. It is an opportunity to establish a real value chain which gives good positioning in the market place and differentiate the firm's product from competitors. A choice is left to the firm as for choosing new supplier or investing in a waste collection organization system to support the production. In this way, the firm will turn to be its own supplier of raw material. Our next research will be oriented to the implementation of green practices within the distribution system.

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