Sustainability Assessment of Brita Filters
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Access to clean drinking water is a basic need, a right that should be extended to everyone. Becoming increasingly controversial and important in this discussion is the issue of how to provide this amenity on a large scale with varying levels of infrastructure development and quality assurance. This document provides a preliminary sustainability assessment of Brita water filters in order to outline the direct implications of choosing this product over alternatives.

Significance of the Assessment

Brita® filters were first established in 1966 to optimize tap water with respect to the fact that some people were in search of better tasting water, while others looked for a way to avoid health concerns related to tap water consumption (Brita, 2010). After nearly a half century, Brita claims to reduce copper, chlorine (taste and odor), and mercury levels with their popular pitchers. Their Faucet filtration product also advertises a reduction in lead, benzene, TTHMs (Total Trihalomethanes), and microbia cysts (Brita, 2010). Their products are certified under the Water Quality Association (WQA) Gold Seal Product Certification Program, which ensures that they meet standards for specified contaminant reduction, structural integrity, and material safety. The Faucet filtration system further meets the NSF/ANSI standards for lead reduction. Today, Brita is the leading maker of "point-of-use" water filtration products. For this reason, we believe a sustainability assessment of this product is paramount to determine the environmental and societal impacts of using Brita filters as an alternative to bottled water or other filtration systems. To do this, we will need to conduct a material assessment of the product, determine the significance of using these materials, as well as conduct a similar assessment of alternatives. Following will be a discussion of the social and political implications of corporate policies related to the Brita corporation and its practices.

Are filters necessary? A case study

According to the EPA, the threat to drinking water is growing as dangerous contaminants are being found increasingly in tap water, with many municipal water systems not meeting water quality standards. Thus, water filtration systems are seen as the green choice for safe drinking water, in comparison to alternatives such as bottled water, according to the May 2010 Consumer Reports Magazine. The Environmental Working Group funded tap water tests in the District of Columbia in May of 2007 which revealed very high levels of toxins far beyond the annual federal health safety limits. Specifically, the chloramine by-products such as Haloacetic acids or

HAAs, have been classified by the EPA as carcinogenic to humans. Long term exposure to such toxins at levels seen in the District of Columbia can have very dangerous health risks such as brain, nervous system, and reproductive system injuries. Following the results of this tap water test, carbon filters were recommended by the Environmental Working Group for one million residents consuming the tap water.

Having access to clean drinking water is a basic need, and in the United States, a luxury that many citizens take for granted. In our society we have the ability to satisfy this immediate need in a variety of ways. Today when you're thirsty you can grab a water bottle, take a drink from the tap, or even utilize a filter. It is important to understand the risks involved in each method, so you are able to make a safe and educated decision when it comes to how to quench your thirst.

The common misconception that tap water is somewhat impure is entirely false. The bottled water industry is self-regulating, which means that they can pick and choose the tests their product undergoes as well as the information they choose to disclose to the public. The Food and Drug Administration only regulates bottled water in interstate commerce. Most of these companies can afford to monopolize in many areas and manufacture and sell their product in state, which means they do not need to meet FDA regulations (Tapped). Many popular brands of bottled water contain high sodium content, some with over 10mg/liter of sodium. Americans consume on average 1.5 to 3 times the recommended daily sodium intake, which contributes to health concerns such as rising obesity rates, and high blood pressure (Schemer). Bottled water is also not sterile. It contains trace amounts of bacteria naturally present or introduced during processing. An additional reason to rethink buying plastic water bottles is because they are made from polyethylene terephthalate (PET). PET has been deemed safe by the bottled water industry for one-time use, and refilling water bottles increases the risk of chemicals leaching into the water. The toxin DEHA also appeared in water samples from reused water bottles. DEHA has been shown to cause liver problems, other possible reproductive difficulties, and is suspected to cause cancer in humans. Other plastic water products contain certain types of dangerous phthalates and bisphenol A, which may also seep into the water (Tapped). These toxins can disrupt the endocrine system, hormone balance, and can even cause fatigue and weight gain (Schemer). Lastly, bottled water is more expensive than tap water even though it is not as pure. The bottled water industry in a sense does not consider providing safe drinking water to consumers a priority.

To ensure that tap water is safe to drink, the U.S. EPA prescribes regulations limiting the amount of certain contaminants in water provided by public water systems. The City of Burlington is fortunate to have Lake Champlain as a source for our raw water. The point of intake is located well beyond the Burlington Harbor near the widest portion of the lake. Burlington Public Works Water Division obtains this raw surface water and then treats it at their facility (BPW Representative). Substances that may be present in source water include: Microbial Contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, or wildlife; Inorganic Contaminants, such as salts and metals, which can be naturally occurring or may result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming; Pesticides and Herbicides, which may come from a variety of sources, such as agriculture, urban storm water runoff, and residential uses; Organic Chemical Contaminants, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production and may also come from gas stations, urban storm water runoff, and septic systems; Radioactive Contaminants, which can be naturally occurring or may be the result of oil and gas production and mining activities (Annual Water Quality Report). In order to prevent any of these contaminants from causing harm to the public the water treatment process becomes more thorough back at the facility.

Water suppliers use a variety of treatment processes to remove contaminants from drinking water. These individual processes may be arranged in a "treatment train," a series of processes applied in sequence. “The most commonly used processes include filtration, flocculation and sedimentation, and disinfection for surface water” (Treatment). Some treatment trains also include ion exchange and adsorption. Water utilities select a combination of treatment processes most appropriate to treat the contaminants found in the raw water used by their system. Flocculation refers to water treatment processes that combine or coagulate small particles into larger particles, which settle out of the water as sediment. Alum and iron salts or synthetic organic polymers are generally used to promote coagulation. Settling or sedimentation occurs naturally as flocculated particles settle out of the water.

Many water treatment facilities use filtration to remove all particles from the water. Those particles include clays and silts, natural organic matter, precipitates from other treatment processes in the facility, iron and manganese, and microorganisms. Filtration clarifies water and enhances the effectiveness of disinfection. Ion exchange processes are used to remove inorganic contaminants if they cannot be removed adequately by filtration or sedimentation. Ion exchange can be used to treat hard water. It can also be used to remove arsenic, chromium, excess fluoride, nitrates, radium, and uranium. Water is also disinfected before it enters the distribution system to ensure that potentially dangerous microbes are killed. Chlorine, chloramines, or chlorine dioxide are most often used because they are very effective disinfectants, not only at the treatment plant but also in the pipes that distribute water to our homes and businesses (Treatment, p.1). Ultra-violet radiation is also a technique used to disinfect water at treatment plants.

BPW Water Division utilizes chlorine to disinfect its water before it leaves the plant. For this reason you can frequently taste chlorine in the water when drinking from the tap. This results in many people seeking an additional filter to purge the chlorine taste. Chlorine will evaporate out of the tap water given time, but for many that is inconvenient. Companies such as Brita thrive from marketing themselves as a “necessary” purifying filter that gives your tap water that fresh, wholesome taste. An activated carbon filter can reduce the amount of chlorine added to your water as well as reduce VOCs (volatile organic compounds) formed during chlorination. Activated Carbon/Charcoal filters work in this way: “water passes through an activated carbon filter, the VOCs bond to active sites in the carbon passages and are removed from the water.

Over time, the active sites fill up and the filter is no longer effective. If the filter continues to be used at this point, the VOCs may be released back into the filtered water. It's also important to follow the maintenance schedule recommended by the manufacturer because disease causing bacteria can build up in the carbon of poorly maintained filters" (Treatment).

Materials Analysis

This section of the sustainability analysis will focus on the plastic components found in standard Brita water filters. Of these there are two components which are definitely made out of plastic and one component that most likely is. The component which is likely made out of plastic is the cation exchange resin found in the Brita filters. However, information on the material components of the cation exchange resin is proprietary. Therefore it is only possible to speculate on what its components are; by looking to common trends in the production of ion exchange resins. Because of this fact the section on the cation exchange resin will come first. According to the New Zealand Institute of Chemistry the most common material used in the manufacture of cation exchange resins is polystyrene with attached sulphonate groups (acting as the exchange mechanisms) (Alchin, 1). This study will operate on these assumptions by including a secondary analysis based on the possibility that polystyrene is the plastic of choice. To do such an analysis it is important to know the internal composition of the filter, by weight. I weighed the contents of two Brita filters and found the internal materials to weigh 94.4 g, 95.6 g, and 95.4 g. From this material I weighed out 13 g, which I separated into its respective components. The final weight for cation exchange resin was 5.1 g (39%) and the final weight for the activated carbon was 7.9 g (61%). Because the process involved was not perfectly accurate, or diverse, in its sources I feel it is reasonable to use the more generalized numbers of 40% and 60%. This then means that, with an average weight of 95.13 g, the cation exchange resin per filter totaled 38.05 g and the activated carbon totaled 57.08 g.

The above information allows me construct a generalized assessment of what a sustainability analysis might look like for the cation exchange resin. The only data I could find which provided me with an estimate of the production inputs for polystyrene came from the data sets used by a carbon calculator put together by the University of Manchester, in England. The number this carbon calculator used was 3.38 kg of CO_2 emissions for every kg of polystyrene produced (carbon calculations, 92). This means that the production of 38 g of polystyrene is responsible for the emission of 128.44 g of CO_2. Again, however, this number should not be viewed with too much weight because the composition of the cation exchange resin remains a mystery.

The two components which definitely are made of plastic, and which I have the ability to analyze, are the styrene acrylonitrile and polypropylene plastics of the Brita container (Barmeyer), and the polypropylene plastic of the filter housing. The specific pitcher used in my part of the assessment is the Brita slim pitcher. This paper will start its analysis with the polypropylene (PP) found in a Brita filter and pitcher. I have weighed the PP filter case and found it to weigh 16.7 grams, while the polypropylene for the rest of the container to weighs 232 g. From this weight I can apply a lifecycle analysis, prepared by Boustead (2000), and accessed through The Journal of Biotechnology. The above lifecycle analysis is comprehensive in nature, covering:

> "all raw material and agricultural inputs, detergent and enzyme use and wastewater treatment. It takes CO2 uptake into account during the sugar cane growth for glucose requirements. It excluded the impacts of construction of the process plant and equipment maintenance" (Harding, p. 6)

This analysis will enable me to determine the material and energy inputs necessary to manufacture 248.7 g of PP, as well as some of the toxic byproducts caused by said manufacture.

First, the manufacture of PP generates 3.4 kg of CO_2 emissions for each kg of PP produced (Harding, p. 9). For one Brita filter this equates to 845.58 g of CO_2. In terms of materials and energy polypropylene consumes: 85.9 mega joules of electricity/kg PP, 1,050 kg propylene/1,000 kg PP, 75 kg of oil/1,000 kg PP, and 61 kg of refinery gas/1,000 kg PP (Harding, p. 6-9). Translated into energy usage per filter the figures are: 21.36333 MJ electricity, 261.135 g propylene, 18.6525 g oil, and 15.1707 g refinery gas. As for toxic emissions the production of 1,000 kg of polypropylene releases 37 kg of both NMVOC *(non-methane volatile organic compounds)* and NOx (NO and NO_2) as well as 2.5 kg of particulate matter. In terms of one Brita filter this translates to 9.2019 g of both NMVOC and NOx, and .62175 g particulates (Harding, p. 6).

As for the styrene acrylonitrile this portion of the filter was weighed to found to be a total of 390.5 g. The average compositions for styrene acrylonitrile are roughly 70% styrene and 30% acrylonitrile (*Encyclopædia Britannica).* I can again use data from the carbon calculator put together by the University of Manchester. According to the calculator each kg of styrene acrylonitrile manufactured has created 4.06 kg of CO_2 by the time it leaves the factory (Carbon Calculations, 222). This means that the manufacture of 390.5 g of styrene acrylonitrile generates 1.597145 kg of CO_2 emissions.

CO_2 Emissions Generated by the Manufacture of a Brita Filter plus Brita Pitcher:

Raw Material	CO_2 Emissions
Polypropylene Plastic (248.7 g)	845.58 g CO_2
Styrene Acrylonitrile (390.5 g)	1.597145 kg CO_2
Polystyrene (hypothesized)	128.44 g CO_2
Totals (not including polystyrene)	**2.442725 kg CO_2**
Totals (including polystyrene)	**2.571165 kg CO_2**

Byproducts Produced by the Manufacture of 248.7 g of Polypropylene:

Specific Byproduct	Emissions per Filter
Electricity Usage	21.36333 MJ

Propylene Usage	261.135 g
Oil Usage	18.6525 g
Refinery Gas Usage	15.1707 g
NMVOC and NO_x Emissions	9.2019 g
Particulate Emissions	.62175 g

Background on carbon water filters

Carbon filters have been used for centuries. Carbon is a very powerful absorbant, containing a surface area of 125 acres per pound. It has the potential to absorb thousands of water contaminants through its millions of pores. There are three types of carbon that are typically used in water filtration systems; bituminous, wood, and coconut shell carbon, with coconut being the most effective of the three.

There are two types of carbon filters: carbon block and granulated activated carbon. Carbon filters will have reduced efficiency over time, requiring regular filter replacement. Although unable to remove heavy metals, carbon filters should remove chlorine, chloramine, endocrine disruptors, pharmaceutical drugs, pesticides, and disinfection by-products.

5 stages of filtration

1. micron sediment pre-filter, removing dirt, sediment, and large particles
2. 2. Reduces iron, mercury, copper, and other metals
3. ion exchange resin reduces heavy metals and softens water
4. granulated activated carbon reduces chlorine, pesticides, and chemicals

Sustainability of Carbon

One filtration study of Water Research evaluated the use of nutshell granular activated carbon. Specifically, almonds, English walnuts, and pecans were studied. The nutshell based carbon system was referred to as “Envirofilter”, and was compared to four commercial systems including BRITA. Results of the study indicated that of all the systems evaluated, the acid-activated almond shell and steam activated pecan and walnut shell based carbon were the most effective in removing the metal ions tested (copper, lead, and zinc). The results lead to a conclusion that “Envirofilters” require less carbon than commercial filters including BRITA to achieve the same metal absorption efficiency.

The Life Cycle of a Brita Filter

Each Brita filter lasts about 40 gallons, which is approximately 2 months for the average family. After that, they must be replaced, and an entirely new filter is inserted into the product. These filters have an indefinite shelf time, But must be kept at cool and dry temperatures until used. As far as maintenance, Brita offers many replacement parts including lids, reservoirs, flip lids, and pitcher jugs (Brita, 2010).

Brita has decided to collaborate with Preserve® to create a 100% recyclable product. When a Brita filter is no longer usable, is must be brought to a Gimme 5 location to be recycled or mailed to Preserve. Instructions are outlined specifically on the Brita website (Brita, 2010). Preserve takes the filters and makes them into a second product which is also 100% recyclable. The filter ingredients specifically are also recycled into products or used for energy production. John Lively, director of environment and material science for Preserve, says that his team has, “Calculated that the benefits of keeping Brita filters out of landfills outweigh the impact of shipping them for recycling through this program. (Brita, 2010). While it seems feasible, Lively did not back up that statement with any specific evidence. Although Brita advertises filters that are 100% recyclable, the fact that the contents of the filter are often burned for energy must be noted. The filters themselves do not become products after they are used.

Comparison of Brands

	Crystal Quest Pitcher Filter	Culligan OP-1	Brita Deluxe	PUR CR-900	"White Label" CVS, other
Pitcher Price	$24.95	$15.99	$32	$29	$21.99 Brita
Capacity, cups	10	8	10	10	8
Filter Life, months	**6-12**	2	2	2	2
Filter Life, gallons	**2,000**	40	40	40	40
Filtration Stages	5	2	3	2	5 advertised, 3 actual*
Filter Cost (approx.)	$16	$7	$7	$10	$9
Cost of ownership, 2 Years (approx.)	**$41 - $73**	$93	$120	$139	$121

Alternative Filtration Systems

Another type of filter is a sediment filter. Sediment filters range from woven fabrics to foams and blocks. They are made out of ceramic clay, extruded carbon, or poly-ethylene. Next are water distillers which heat water to create steam, which is then cooled to create purified water. Problems with purified water include the lack of minerals and negative health effects as a result. Ceramic filters are another option, made up of Diatomaceous Earth, which is a substance made up of silicon shells from single celled algae (diatoms). This type of filter is slow, but contaminants can be easily scrubbed off of the ceramic material. Reverse osmosis filters use pressure to purify water through a membrane, removing all of the minerals in the process which is less preferable for health reasons to water with minerals. Next are ultra violet radiation systems which use high frequency light to irradiate water through glass, killing all living organisms as the water is exposed to the light. Such systems are popular in areas where the risk of serious disease from the water is high.

Home-made water filters can be made using charcoal and moss as filtering agents. Birch, willow bark, moss, carbon, sand, and sticks are all needed

Social Implications of the Brita Group

The Brita Corporation touts itself as a socially engaged and responsible organization donating to important charities and marketing products specifically designed to promote charitable causes; for example, the Brita-Orla Keilys collaboration supporting breast cancer care and research through sales of a special edition Hydration Pack (Mattu, 2010). Addressing needs in developing countries, the Brita Group entered a cooperation agreement with the United Nations International Children's Emergency Fund (UNICEF) in 2007 supporting their program to deliver clean drinking water to Vietnamese villages. Over the course of three years the Brita Company supplied clean water systems to over 200,000 people. However, at the start of this year, Markus Hankammer (the CEO of Brita Group) made a statement that despite the wonderful success of the relationship, his company would sever ties with the UN program and direct its philanthropic mission elsewhere (Hankammer, 2010). Surprisingly, no literature was found documenting the cooperation between the two organizations besides the corporate website; there was also no information on the business's current or future charitable involvement.

Corporate business often gets a bad name due to the traditional (and legal) model of profit maximization and loyalty to shareholders. Nevertheless, the size of multinational corporations does allow them to play a significant role in charitable aid programs. The positive change that big businesses influence must not be disregarded because of the terrible costs often externalized by those same institutions. From a sustainability perspective, any social or environmental benefit is a step in the right direction and ought to be recognized as such. There *must* be participation at all scales to address global issues. After all, if those without the resources of an international business were charged with injecting large amounts of money and technology into communities in developing countries everyone's quality of life would be lower.

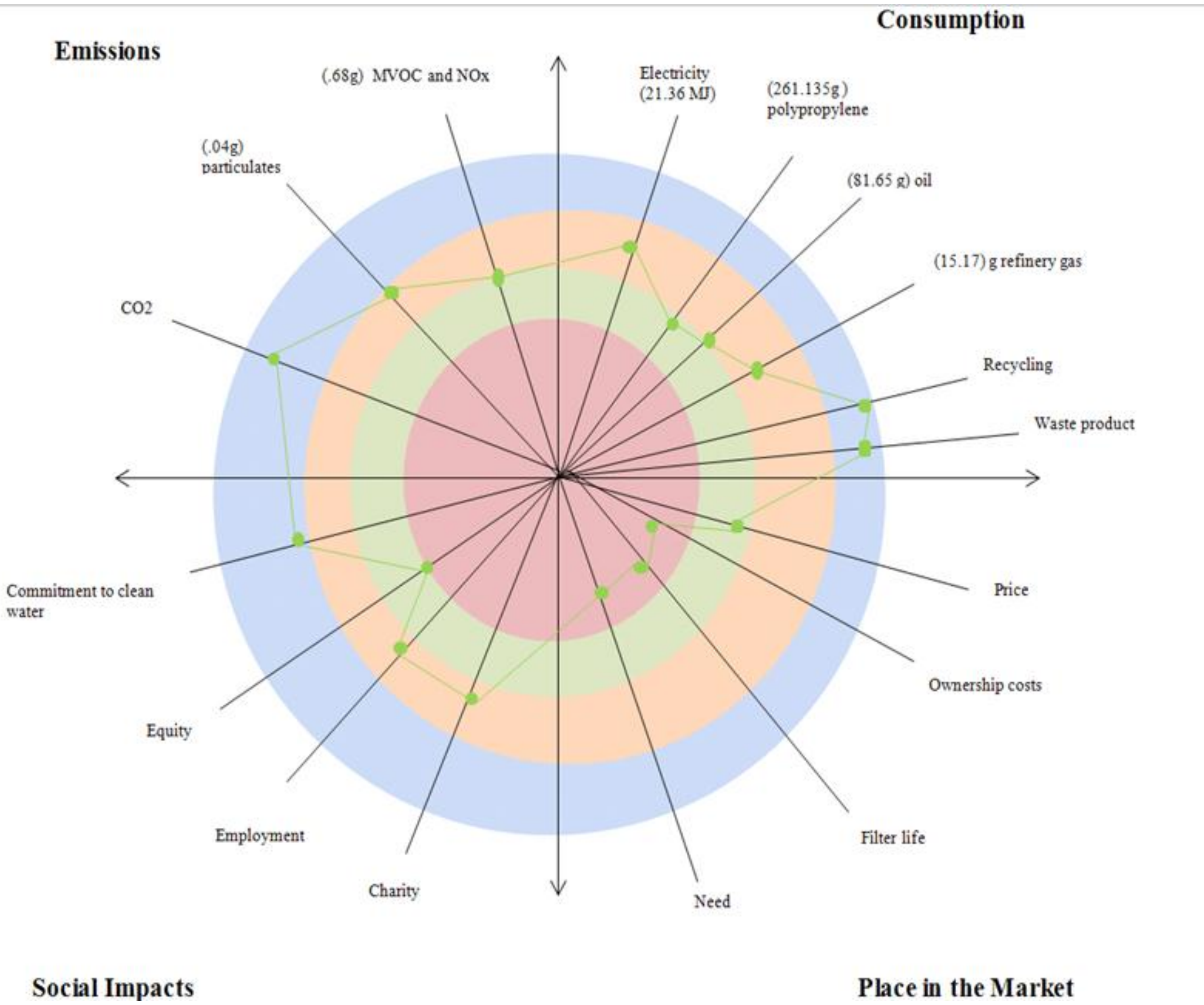
Large corporations play an important role in the developed world as well. The German based Brita Group (excludes the sector of Brita run and controlled by Clorox in North America) directly employs nearly one thousand people - indirect employment in marketing, distribution, etc. accounts for a vastly greater number of jobs - and was ranked in the top one hundred employers in Germany for the second year in a row, receiving the Top Job award in 2009 (Brita Worldwide, 2010; Rholf, 2009). In the Americas, the Clorox Corporation’s website boasts expansive employee benefits and community building programs (such as a peer-to-peer recognition program acknowledging and empowering efforts and achievements of colleagues) within the workplace. Creating positive work environments is an important part of a responsible business and a facet often included in determining the `sustainability' of a company (Investing in our People, 2010).

An eye-catching sentence of a Clorox web page was the explicit statement that benefits are available and provided not only to spouses and children but also to same-sex partners (Investing in our People, 2010). This was the first time any of the researchers had encountered explicit mention concerning challenges commonly faced by employees participating in what is too often perceived as an alternative lifestyle. In a constantly diversifying and liberalizing world, offering accepting and equitable accommodations and compensation is an increasingly essential component of a sustainable society.

A publication from the Harvard Business press suggests that at the turn of the (21st) century “the period of increasing returns seem[ed] to be coming to a close” for the Brita corporation and that in order to perpetuate the business's viability new markets must be explored (Deighton, 1999). Of course a business must grow and seek new markets however, from a sustainability perspective growth ought to have a purpose. This is often overlooked in sustainability discussions, *sustainability for or of what*? The Brita Corporation chose to expand to new markets, but with the additional - although not indicated - social benefit of providing resources to a struggling region.

Brita filtration products are a luxury item, they are not intended to purify non-potable water or improve the safety of the water, instead they are favored to improve the taste of municipal water. However, in 2001, the Brita group entered a joint venture with Usha Shriram and Indian appliance corporation to bring clean water to the North Bengal and Sikkim regions of India “[perennially] plagued” by water contamination (Usha Brita Initiative, 2006). This collaboration between corporations developed new technologies to improve human health and quality of life at a household scale. This market expansion represents a business development that is not only fiscally beneficial to the two corporations, but also has the potential to be socially beneficial. The use of household filters could also help to reduce the reliance on chemical additives to public water sources, therefore decreasing environmental impacts of water issues in this region of India.

The social impacts of this eastern expansion are notable and are generally lauded in the researched literature. Although it should not detract from the socially and environmentally positive aspects of the market shift, the business implications are obvious. Just two years after Deighton's article highlighting the need for new markets, the venture in India opens markets in Southeast Asia, Africa and the Middle East. What's more, these markets are often much less elastic than the luxury goods market in the Global North, indicating the `need' for this product and suggesting goldmine for the Brita Group (India to be Export Hub…2006). According to this article the development of a regional manufacturing and distribution center will more easily and effectively serve the needs of the area. For instance, door to door vending may be a more effective method of distribution in rural areas says Anupam Bharat the managing director of the company (India to be Export Hub…2006).



The above figure is a representation of Brita's success in emissions, in total consumption, in society, and in the market for alternatives. We believe these factors give an adequate picture of how sustainable this product is.

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