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DEPARTMENT OF SUPPLY CHAIN AND INFORMATION SYSTEMS

THE IMPORTANCE OF THE CONSUMER LINK IN SUSTAINABLE SUPPLY CHAINS: INVESTIGATING PLASTIC WATER BOTTLES AND PLASTIC TOTES

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Abstract

The purpose of this paper is to investigate the influence of consumer decisions on sustainable supply chains by considering the environmental effects of two consumables: single-use plastic water bottles and plastic tote bags. Each of these products has an initial design, alternative form, and substitute product for consumption. Each of these has a different impact on the environment. There are three key insights resulting from this work. The first is that plastic is the common offender in water bottles and tote bags, i.e. it is the plastic material in both that causes a potentially disastrous impact on the environment. The second key insight is that consumption of water bottles and tote bags continues despite perceived environmental threats. Third, this work points out the importance of considering adoption of substitutes to avoid further harm to the environment.

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Chapter 1

INTRODUCTION

1.1: Purpose of this Paper

The purpose of this paper is to investigate the environmental effects of consumer decisions on sustainable supply chains for plastic water bottles and plastic totes. The intent of this work is to gain insight into how consumers are linked to the success or lack thereof of sustainable supply chains for consumable plastic water bottles and plastic totes.

With the increasing global emphasis on climate change and the footprint that human actions leave on the environment, scientists and researchers are finding ways to create products and processes that are more environmentally conscious. Although innovative and environmentally conscious products have entered the market, consumers seem slow to adopt many of these innovations into their daily lives. It is the consumer link where many earth-conscious products lose their potential to reduce environmental impact.

This thesis takes a look at two different consumer products across two different industries: single-use plastic water bottles and single use plastic tote bags (e.g. grocery store bags). The research reveals how these products have undergone significant sustainable supply chain innovations and how consumers seem reluctant to adopt these changes. A product, such as plastic water bottles and plastic tote bags, manufactured with more recyclable components is only better for the environment if the end user places the packaging in the recycling bin or reuses it. Even if the consumer recycles it, there may be no infrastructure in place for that particular type of plastic to be recycled in one's local area. Unless a plant can fully recycle the product packaging, the packaging innovation is seemingly useless, as it will clog landfills like many products currently used today. This thesis analyzes scenarios associated with plastic water bottles and plastic tote bags and considers alternatives and substitutes that leave a smaller footprint on the environment. Through improvements such as reducing materials usage from the beginning, enhancing biodegradability, and reducing various additional costs to the environment, scientists are making breakthroughs in new eco-conscious products. Consumers are an important part of the implementation of such breakthroughs.

The single-use plastic water bottle industry is one of many industries that is producing and consuming plastic at an alarming and unsustainable rate (Fishman 2007). Recent innovations in packaging have had an impact in reducing plastic that enters landfills, while other innovations remain stagnant because consumers have not fully adopted them. Aquafina reduced the plastic content in their Ecofina bottles this past year by 35-percent (Aquafina 2010). This translates into a reduction in plastic entering landfills, however it is a small one because Aquafina is just one brand in a very satiated international water bottle market.

Environmentally conscious packaging innovations such as Brazil's Life in Box water, uses biodegradable corrugate made from sustainable and recycled wood content and a recyclable plastic bag (DuPont 2008). Although this is the most progressive packaging development for water bottles, consumers meet this change with reluctance. A substitute for the classic single-use plastic water bottle is the aluminum and stainless steel reusable water bottles on the market today. While environmentally friendly, these water bottles can be inconvenient for the consumer to use. Disposable bottles have shaped parts of consumer's daily lives. Nearly every car in the U.S. has cup holders, which cater to plastic water bottles instead of reusable water bottles (Fishman 2007). The decisions in consumption that humans make everyday such as choosing a disposable plastic water bottle versus reusable water bottle have a profound impact on the planet.

Plastic bags are cheap to produce, sturdy, easy to obtain, and easy to carry and store. Plastic bags have taken over more than 80-percent of the grocery store and convenience store markets (Roach 2003). These totes line trashcans, are used as lunch bags, and carry gym clothes, among many other tasks; but no one really knows when and if they will degrade. Some scientists predict that a plastic bag will take over 1,000 years to degrade (Cobb 2010, Jedlicka 2009, Horovitz 2008, Roach 2003). Consumers frequently use these bags despite the fact that they are clogging landfills.

Additionally, each year millions of plastic bags enter the ocean and harm the fragile marine ecosystem (Roach 2003). Substitutes for plastic totes include sturdy reusable totes that are slowly becoming available across grocery stores in the United States. Again, there is a disconnection at the consumer link in the supply chain. A consumer is first faced with the choice of paper, plastic, or reusable bag. Most consumers opt for plastic bags, which end up in landfills (Roach 2003). There is data that supports that plastic bags are harmful to the environment, however consumers are not aware or simply do not care.

Stores such as Wal-mart and Wegmans have created plastic bag recycling terminals at their stores, however the fact remains that most consumers do not recycle them (Cobb 2010). If a consumer opts to use reusable bags, they are drastically decreasing the number of bags per year that they contribute to landfills across the U.S. Very few individuals have adopted this trend. In response to low adoption rates, countries like Australia have implemented a tax on using plastic totes that leave not only an eye sore littered across beaches, but also harm the fragile marine ecosystem that surrounds Australia (Roach 2003). From fossil fuel emissions to overflowing landfills, human actions are leaving a weighty footprint on the environment.

1.2: Approach to Research

The value of changing consumer patterns and habits is evident from the expansive media and press coverage on climate change, pollution, and other environmental concerns. The importance of change and adaptation in consumer habits with regards to plastic water bottles and plastic totes is the motivation for this thesis.

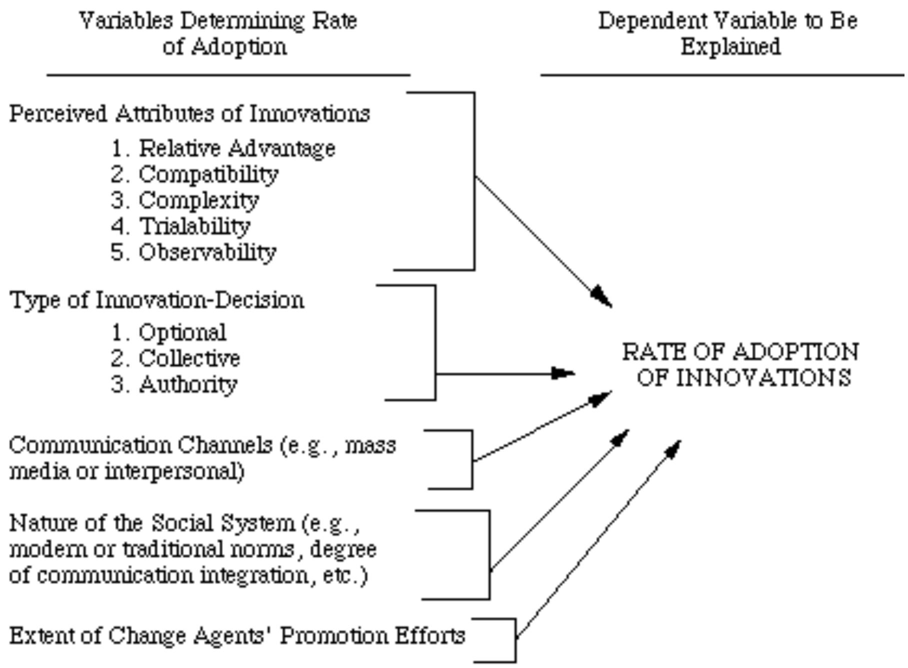
This thesis analyzes three scenarios for two products, which have experienced environmental innovations. Each product has an initial, alternative, and substitute option for consumer consumption. The consumer can purchase the initial, alternative, or substitute and ultimately has the option of reducing use, reusing the product, recycling the product, or disposing of the product. Each of these scenarios produces an externality that is relatively favorable or unfavorable in comparison to the other scenarios.

The approach to this thesis includes a review of the complex initial product supply chains from raw materials to the finished product. It also takes into account the life cycle of the product from creation to destruction. Facts and figures regarding the production, consumption, and disposal of these products come from publically available data. This data illustrates the impact that plastic water bottles and plastic totes have on the environment.

Scientists have made countless innovations over the last century, some that consumers quickly adopt and others that consumers forget about. One of the most notable and comprehensive books discussing the adoption of innovation is Everett M. Rogers', "Diffusion of Innovation." The text details the diffusion process of innovations through society, citing examples such as the Internet, QWERTY keyboard, and rap music (Rogers 2003). The text also provides a common framework for the variables that determine the adoption rate of innovations. These variables can either hinder or help new innovations obtain widespread adoption. With consumer lifestyles accustomed to current consumption patterns and habits, it can be hard to see what innovations will succeed or fail to meet consumer demands (Rogers 2003).

There are perceived attributes of innovations such as organizational factors and narrow communication channels that often impede and reduce the adoption rate of profound innovations (Rogers 2003). Figure 1 below shows the variables that determine the adoption rate of an innovation. Rogers' compiled this graphic after completing years of research on the diffusion of a diverse array of innovations.

Figure I: Variables Determining the Rate of Adoption of Innovation



This thesis focuses on the environmental impact of various innovations in plastic water bottles and plastic tote bags. This work will explore perceived attributes of innovations that are key variables in determining the adoption rate of an innovation (Rogers 2003). More specifically, the research will explore these variables in reference to the consumer option among water bottles and plastic bags with the least environmental impact. As shown in figure 1 above, Rogers outlines five perceived attributes of innovations that directly impact adoption rates (Rogers 2003):

- *Relative Advantage* – "is the degree to which an innovation is perceived as being better than the idea it supersedes." Economic profitability, social prestige, overadoption and incentives help express the degree of the relative advantage.
- *Compatibility* – "is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters."

- *Complexity* – "is the degree to which an innovation is perceived as relatively difficult to understand and use."
- *Trialability* – "is the degree to which an innovation may be experimented with on a limited basis."
- *Observability* – "is the degree to which the results of an innovation are visible to others."

According to Rogers, organizations can facilitate the adoption of many innovations. The type of innovation-decision can heavily impact adoption rates (Rogers 2003). This portion of the analysis will look at actual cases of organizations adopting more progressive environmental legislation based on the type of innovation-decision. Rogers indentifies three types of innovation-decisions that impact adoption rates (Rogers 2003):

- *Optional* – An individual makes the decision to adopt or reject an innovation independent of other affiliates of a system
- *Collective* – A consensus of among members of a group make the decision to adopt or reject an innovation
- *Authority* – Relatively few individuals possessing significant authority and power, privileged social standing, or elevated technical knowledge make the decision to adopt or reject an innovation

1.3: Overview of the Thesis

This thesis delves deeper into understanding the environmental effects of consumer decisions on sustainable supply chains. In chapter 2, the single-use plastic water bottle and its alternatives and substitutes for consumption are investigated. In chapter 3, the single-use plastic tote bag and its alternatives and substitutes for consumption are investigated. Chapter 4 of this thesis contains a summary of the environmental effects of plastic water bottles and plastic-shopping totes discussed in chapters 2 and 3. Chapter 5 provides three key insights drawn from the analysis of these products. Finally, chapter 6 discusses limitations and future research opportunities that have arisen from this work.

Chapter 2

PLASTIC WATER BOTTLES: THE CONSUMER DILEMMA

2.1: Discussion of the Current Problem

The typical single-use plastic water bottle is prevalent across the world, in developed and developing nations (Larsen 2007). These bottles are relatively lightweight, convenient, and cheap to produce in comparison to other types of bottles. Research indicates that consumption of bottled water has been increasing drastically over the last decade. As shown in appendix A and B, in 2006, world consumption of bottle water was 47 billion gallons of water, up 64.6-percent from 2000 (Larsen 2007). With global demand increasing significantly each year, the water bottle industry market has become satiated with competitors boasting features such as great tasting, flavorful, artisan, and natural spring waters (Duffy 2009). Due in part to clever marketing campaigns, the simple single-use plastic water bottle has become popular to many because of its convenience, appearance of purity, and perceived cleanliness.

Global implications of bottled water extend beyond simply clogging landfills. The production of the plastic bottle itself requires millions of barrels of crude oil and natural gas, both of which are a non-renewable resource (Larsen 2007). The bottles themselves will take 1,000 years to degrade and some scientists do not believe the plastic bottles will ever fully degrade (Arnold and Larsen 2006). Although an overwhelming majority is not recycled, if recycled, plastic bottles would not be used as an input in making another water bottle. Instead, recycled plastic resin would be used in other goods such as carpet and apparel (Design Boom 2010).

Another issue stemming from bottled water is water scarcity and pollution. Water is essential resource that will be heavily impacted by human actions. The production of water bottles is a fossil fuel intensive production process from start to finish given the nature of the bottles' composition and its' transport (Fishman 2007). These fossil fuels directly impact climate change. According to the Stern Review, regions such as the Mediterranean, Southern Africa, and South America could potentially experience decreases in water availability as a result of climate change. According to various models, water run-off is expected to decline by 30-percent (Stern 2007).

Brands such as Poland Spring and Fiji obtain their water from natural springs and aquifers. The company plants run constantly and pollute the surroundings. Bottled water is so popular that Poland Spring frequently runs its natural spring dry. As a result, the company must send trucks to other springs in Maine just to keep up with the growing demand (Fishman 2007). In the U.S. water bottles sales have been growing 10-percent each year, despite the fact that neither the bottle nor the water inside of a single-use plastic water bottle is sustainable (Larsen 2007).

Chart I: Scenarios for Water Bottle Consumption

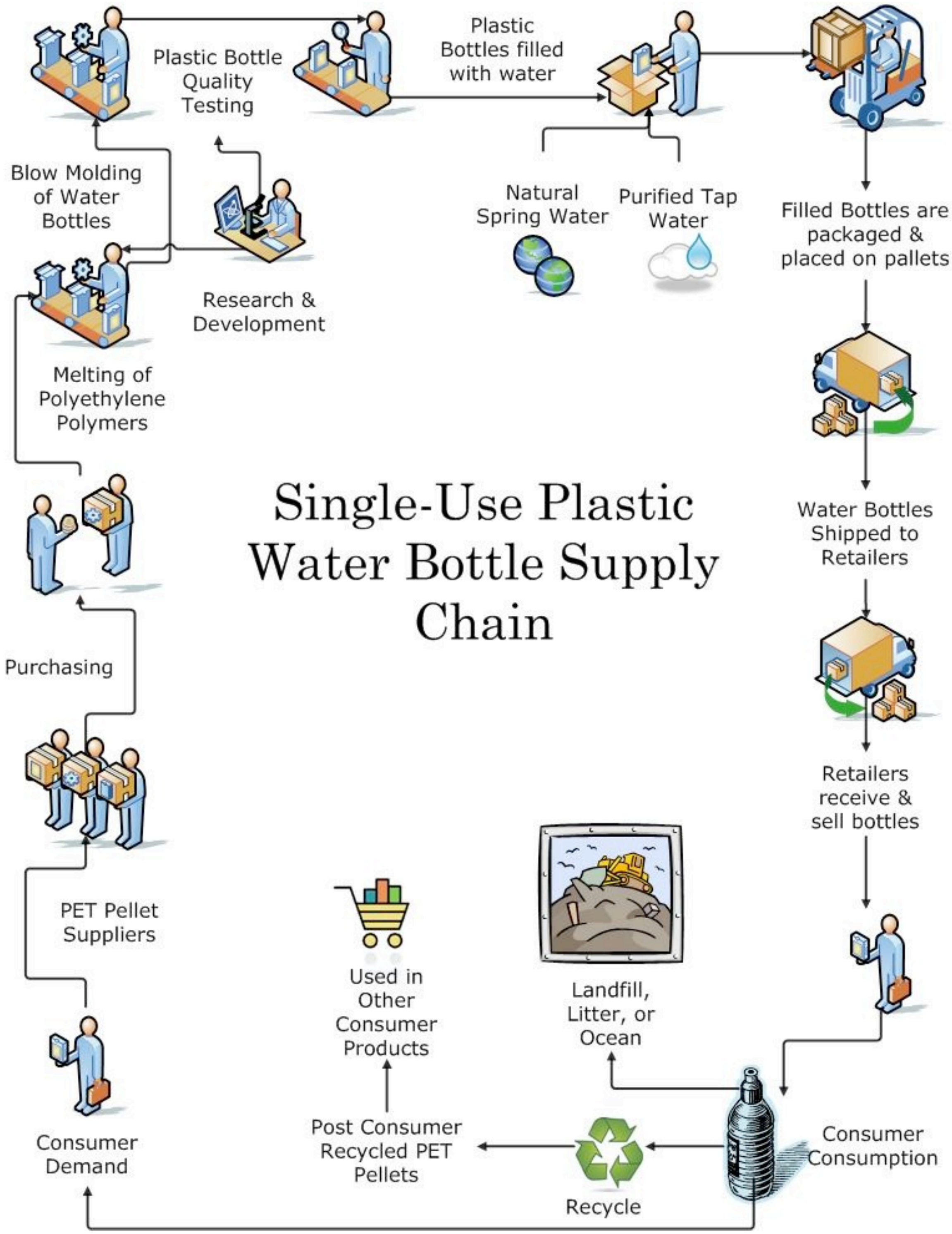
Plastic Water Bottles	Reduce	Reuse	Recycle/ Compost	Dispose	Landfill Waste per person
Initial	Reduce plastic in bottle	Reuse plastic bottle	Recycle the plastic bottle	Dispose after single use	Approximately 167 Bottles/year
Alternative	Reduce non renewable materials	Reuse plastic bottle	Compost/recycle the biodegradable bottle	Dispose after single use	Approximately 167 Bottles/year
Substitute	Reduce/ eliminate use of disposable bottles	Reuse aluminum water bottles	Recycle aluminum and stainless steel bottles	Dispose after multiple uses	Less than 1 Bottle/year*

*Estimate based on a one-year warranty for product, actual amount varies per individual

The following sections will focus on the scenarios summarized in the chart above. The chart above details the potential footprint that one individual can leave in a landfill, depending on the three consumption options available, the initial, alternative, and substitute. The general purpose of a water bottle is to have access to clean water that is portable and convenient. All three scenarios fit that general definition, however they leave drastically different externalities on the environment. Within each scenario, the consumer has the option to reduce, reuse, recycle or compost, or dispose of the product. Discussed in detail in the chapter, this chart reveals that the initial and alternatives will send 167 water bottles to landfills each year, in comparison to less than one bottle per year for the substitute.

Figure I below, depicts the supply chain of the initial single-use plastic water bottle. The purpose of the chart is to show the importance of the consumer link in the supply chain and reveal that consumer demand keeps this cycle perpetuating.

Figure I: The Supply Chain for Single-Use Plastic Water Bottles



The diagram above details a generalized supply chain for the current single-use plastic water bottle that fills store shelves around the country. The entire supply chain is driven by consumer demand for clean, convenient, and portable water. What starts off as small pellets of polyethylene terephthalate (PET) pellets, quickly is blow molded into water bottles and filled with "purified" tap water or natural spring water (AZoM 2010) These bottles are then packaged and shipped across the nation using ocean containers, trucks, and other modes of transport. Once they reach retail locations, consumers purchase cases of water and consume them. After consumption, the consumer is faced with three options, to reuse, recycle, or dispose. An overwhelming majority of plastic water bottles are sent to landfills (Fishman 2007). What is recycled, is turned into recycled resin that cannot be used to create another water bottle, instead this recycled resin enters another supply chain for use (Design Boom 2010).

2.2: Initial Single-Use Plastic Water Bottle

Single-use plastic water bottles are everywhere; they go in lunch boxes, pile up in car cup holders, perfect for the gym, or as the busy-consumer dashes out the door (Fishman 2007). They come in all different shapes and sizes like half-pint, half-liter, and 2.5-gallon jugs for the refrigerator. Consumers these days are willing to pay a premium to obtain water that they perceive to be superior to tap water in purity and taste (Duffy 2009, Fishman 2007). Charles Fishman writes, "Americans love to belittle the quality of their tap water. But in blind taste tests, with waters of equal temperatures, presented in identical glasses, ordinary people can rarely distinguish between tap water, spring water, and luxury waters" (Fishman 2007). Consumers pay more per gallon of water than $3.00 per gallon of gasoline, totaling to over a staggering $15-billion a year (Larsen 2007, Fishman 2007)

Consumers demand single-use plastic water bottles for a variety of reasons. Nearly 47-percent of bottled water consumers attribute health and safety as a reason to consume more bottled water (Duffy 2009). Water bottle manufacturers such as Aquafina, Fiji, Evian, Perrier, Poland Spring, and others have clever marketing campaigns to reinforce the purity of bottled water (Duffy 2009). For instance, Aquafina uses the slogan, “Pure Water, Perfect Taste” (Aquafina 2010). In comparison to the vending machine option of soda, water is a more healthful option, however there is no guarantee that bottled water is safer then the tap water that flows out of a near by water fountain (Duffy 2009, Fishman 2007).

Clever marketing has convinced consumers otherwise, despite reports of harmful chemicals such as bisphenol-A (BPA), an endocrine disruptor, benzene, and bromate among many others, have been found in excess in bottled water (Ortega 2008). Many associate mineral and spring water with medicinal benefits; however there is no scientific evidence that routine mineral consumption is beneficial to health (Fishman 2007). A substitution effect is rising among the public. People are substituting water in place of consuming unhealthy sugar-filled sodas and juices. Although bottled water is a healthier choice, there are environmental and health costs associated with this consumption (Fishman 2007).

Consumer demand and consumption are the driving forces behind the single-use plastic water bottle supply chain (Duffy 2009). The average American demands and consumes approximately 167 plastic water bottles per year. This totals to 50-billion bottles per year for Americans (Fishman 2007). This lengthy supply chain starts with the extraction of crude oil and natural gas from the Earth. The crude oil is converted into

PET pellets through a fossil fuel intensive process and shipped to bottle makers. The manufacturing of just 29-million single-use plastic bottles requires more than 17-million barrels of crude oil (Larsen 2007). The finished bottles are then filled with purified or spring water. According to the Pacific Institute, the environmental footprint of the United States water bottled consumption amounts to over 50 million barrels of oil used in the pumping, processing, transporting, and refrigerating of single-use plastic bottles – equivalent to powering 3-million cars for one year (Larsen 2007). Each week, nearly 1-billion bottles of water are transported throughout the country via ships, trucks, and trains – equivalent to 37,800 18-wheelers delivering water weekly (Fishman 2007). It is clear that the supply chain leaves a weighty footprint on the environment.

It is the consumer link in the supply chain, where consumers have ability to decide to reuse, recycle, or dispose these water bottles after consumption. An overwhelming majority of these water bottles end up in landfills, the ocean, or as litter, costing Americans millions of dollars for clean up annually (PR Newswire 2010). American's throw away approximately 40 billion water bottles or about $1 billion worth of plastic annually (Fishman 2007). The bottles harm marine and animal life and pollute the Earth. Estimates indicate that it will take plastic water bottles 1,000 years to degrade into smaller pieces of plastic that will pollute and mix into soil (Llanos 2005).

Although reports vary between 10-percent to 28-percent, R.W. Beck, Inc. industry consultants suggests that only about 12-percent of plastic water bottles are recycled (Llanos 2005, Fishman 2007, PR Newswire 2010, Environmental Protection Agency 2009). Recycling rates in the United States are so low that domestic plastics recycling plants are experiencing shortages. According to the Environmental Protection Agency, the "capacity to process post-consumer plastics and the market demand for recovered plastic resin exceed the amount of post-consumer plastics recovered from the waste stream" (Environmental Protection Agency 2009). As a result, recyclers ship the bulk of the recycled bottles from the United States to China for recycling (Llanos 2005). The 6,000-mile transoceanic containership voyage to China requires the burning of fossil fuels, releasing greenhouse gases into the Earth's atmosphere. The bottles that are recycled turn into post-consumer plastic resins that are primary used to manufacture fibers for carpet and textiles, not to create more plastic bottles (Environmental Protection Agency 2009).

A prime example of the environmental and ethical issues associated with the production and consumption of single-use plastic water bottles is luxury artesian water company, Fiji Water. Every single bottle of this luxury water is transported first by truck, then by ocean container to the United States, "from the islands of Fiji" as the bottle proclaims (Fishman 2007). Unfortunately, the transport process makes up half of the total cost of the premium water. This means it costs as much to ship Fiji Water across the ocean and truck it to warehouses, as it does to extract and bottle the water. Moreover, the process burns numerous barrels of oil, a finite and environmentally detrimental resource (Fishman 2007). The highly automated facility can churn out 1-million bottles per day, enough to load forty, twenty-foot-equivalent, ocean containers for the transoceanic voyage (Fishman 2007).

Fiji Water's operation runs 24-hours a day and requires a constant source of energy. The local utility provider cannot support this much electrical consumption, so Fiji water runs three, relatively inefficient, large diesel fuel powered generators for a constant supply of energy (Fishman 2007). Although the marketing claims the water originates from a pristine ecosystem, the truth is, the ecosystem is being polluted by fossil fuels (Fishman 2007). Another ethical issue stemming from Fiji Water's production is that more than 50-percent of native Fijians do not have access to safe and reliable drinking water. However, the average American can easily and readily access Fiji water (Fishman 2007). Fiji Water is just one of many bottled-water manufactures that is contributing to the degradation of the environment. Consumer demand drives these companies to produce. As a result, a reduction in consumption could have a positive impact on our environment.

2.3: Alternatives in Plastic Water Bottles

The issues associated with the classic PET plastic bottles have prompted companies to come up with new innovations that address the various environmental disadvantages. The following products are alternatives to the single-use plastic water bottles, but still follow the single-use concept. Bottlers claim these various alternatives are comprised of more environmentally conscious materials than their petroleum based plastic counterpart.

Primo Water Corporation is the first bottled water company to offer plant-based polylactic acid (PLA) bottles nationwide. (Blanding 2009). PLA is a plant-derived resin manufactured through the fermentation of starches from corn or sugar cane. Iowa based NatureWorks, LLC manufactures PLA, also known as Ingeo™. Primo bottles are free from petroleum and are derived from 100-percent renewable resources. These bottles also require less energy in production as compared with plastic bottles (Blanding 2009).

Primo claims that the unique manufacturing process of these bottles helps emits 75-percent less green house gases and uses 49-percent less energy than petroleum based plastic bottles (Primo Water 2008).

Green Planet Bottling is another company manufacturing bottles comprised of Ingeo™. Launched by entrepreneur Brad Schulman in 2008, Green Planet Bottling engineered a plant-based bioplastic. When water heated to 170-degrees hits the bottle, the bottle melts back into 100-percent virgin polymer (Meyer 2010). Clients that use the bottle can earn points towards Leadership in Energy and Environmental Design (LEED) certification. This bottle is currently available to those in the hospitality and food service industries and natural food stores (Meyer 2010).

Another unique alternative is Lindoya Vida, also known as "Life in Box." The product is an octagonal recyclable corrugate box with a recyclable lightweight plastic inner liner. Brazil's largest producer and recycler of paperboard, Klabin manufactures the product's packaging (Murylo 2008). Winner of the DuPont Award for Packaging Innovation, the product touts a unique concept and direction for bottled water (DuPont 2008). Although the product is not available in the United States, it is an example of the growing alternatives to plastic water bottles available throughout the world.

Although these products claim to have a smaller environmental footprint than their plastic bottle counterparts, the consumer has not adopted these innovations for a variety of plausible reasons. For example, Primo 16.9 oz. single-serve water bottles sell in an 18-pack for a suggested retail price of $4.99 (Primo Water 2010). Aquafina's 16.9 oz. EcoFina bottle sells in a 24-pack for approximately $4.74. To the budget conscious consumer, Primo water delivers less value than Aquafina. In addition, Primo single-serve bottles and Green Planet bottles are only available in limited locations (Meyer 2010, Blanding 2009). The Life in Box innovation is only available in Brazil (DuPont 2008).

There are also numerous criticisms to the concept of using PLA in water bottle manufacturing. Environmentalists claim that the production of bioplastics increases the use of pesticides and fertilizers that are harmful to the environment (Blanding 2009). In addition, Van den Berg and Feinstein's economic research reveals that the increasing the usage of corn for fuel and bioplastics reduces the supply of corn and will ultimately increase the market price for corn. They predict that this increase in price could contribute to poverty and hunger in developing nations (Van den Berg and Feinstein 2009). The production of PLA bottles also is more expensive than for the production of plastic bottles. PLA cannot be used as widely as plastic because it breaks down when filled with carbonated beverages (Blanding 2009).

Although these bottles have some environmental benefit, the consumption of single-use bottles still does not address the issue of consumption. If a consumer would switch to PLA water bottles, their average contribution to landfills would still average around 167 bottles (Fishman 2007). If the consumer decides to recycle the bottle, they face a new set of obstacles. PLA cannot be readily recycled in current facilities. Mixing PLA with PET could potentially contaminate large batches of recycled resin (Llanos 2005). In addition, there is no sound infrastructure in place for the recycling of PLA, although NatureWorks, LLC claims to have a PLA buyback arrangement with recyclers (Primo Water 2008). PLA is biodegradable unlike PET plastic bottles, however PLA can only biodegrade in industrial composting facilities, not in a backyard compost bin (Blanding 2009, Enso Bottles 2009).

2.4: Substitutes for Plastic Water Bottles

Viable solutions are available today that can readily substitute for the single-use plastic water bottle. Reusable water bottles reduce waste sent to landfills and promote the use of the energy efficient tap water infrastructures that most Americans enjoy. Aluminum, stainless steel, and BPA-free bottles are sold everywhere across the nation and on online retail outlets (MacLeay 2008). These types of bottles can be refilled countless times and are durable enough to last years, unlike plastic water bottles.

Aluminum reusable water bottles are a viable substitute to consuming single-use plastic bottles. SIGG Switzerland is a reusable bottle manufacturing company. The company manufactures the 100-percent recyclable SIGG, "The World's Toughest Water Bottle" (SIGG USA 2010). This means that after a very long life of usage, the bottle can be completely recycled. The bottle's aluminum composition avoids many of the health concerns associated with plastic, however consumers must be careful to purchase aluminum bottles that are lined with safe materials. SIGG maintains that its bottles do not leach any harmful chemicals and exceed FDA regulations (SIGG USA 2010).

Klean Kanteen offers a wide array of stainless steel bottles. Unlike aluminum bottles, stainless steel bottles do not need to be lined. These bottles are typically comprised of recycled metal alloys. The manufacturer guarantees that the bottles are high quality, long lasting, BPA-free, phthalate-free, lead-free, and can handle acidic beverages and foods (Klean Kanteen 2009). The bottles carry a one-year warranty, but can easily last longer than one-year. Another unique aspect is the slim design of the product, which can typically fit into most cup holders, similar to plastic water bottles

(Klean Kanteen 2009). Another reusable option available to consumers is CamelBak's BPA-free and phthalate-free plastic bottles. These bottles are also reusable and durable. In addition, these bottles retail for significantly less than their aluminum and stainless steel counterparts (CamelBak 2010).

There are a variety of reasons why consumers fail to adopt the practice of utilizing reusable bottles. Consumers prefer the convenience of grabbing a plastic bottle and disposing it after consumption (Fishman 2007). In addition, many consumers claim they are not satisfied with the quality and taste of their tap water, despite the fact that in blind taste tests, tap water was favored (Fishman 2007). Consumers have the impression that recycling means the product is reconstituted again. In the case of plastic bottles, recycled PET rarely if ever, is formed into another plastic water bottle (Environmental Protection Agency 2009, Design Boom 2010).

The environmental footprint left by reusable bottles if significantly less than the initial option of plastic water bottles. Transporting one empty reusable water bottle is significantly cheaper than transporting the 167 single-use plastic water bottles that the average consumer uses annually, based on weight and shipping frequency. In addition, at the end of a reusable water bottles life, a consumer has the option to recycle the bottle or dispose of it. Most reusable water bottle manufacturers offer a one-year warranty (SIGG USA 2010, Klean Kanteen 2009). This contributes less than one bottle to a landfill annually, versus the 167 bottles that would end up in landfills via the initial plastic bottles or alternative bioplastic bottles. In addition, SIGG and Klean Kanteen bottles are 100-percent recyclable, which means that no reusable bottles would ever have to enter landfills.

2.5: Variables Affecting Adoption of Substitute Innovation

Of the three scenarios, the initial, alternative, and substitute, the substitute is more favorable because it leaves a smaller footprint on the environment. Despite this fact, consumers are not readily adopting the reusable water bottles into their daily lives. According to Rogers there are perceived attributes to the innovation that impact its adoption rate. He also notes the impact of the innovation-decision process on adoption rates (Rogers 2003). Innovation attributes that affect the adoption rate include relative advantage, compatibility, complexity, trialability, and observability.

The relative advantage is an influential variable affecting adoption rates. Economic factors directly impact the relative advantage of adoption (Rogers 2003). The reusable water bottle requires a larger upfront cost, than one typical 24-pack of single-use plastic water bottles, which costs anywhere from $4 to $6. However if an individual on average consumes 167 bottles a year at $4 for 24 bottles, the consumer spends $28 per year on bottled water (Fishman 2007). In comparison, the price for a reusable water bottle from Klean Kanteen, SIGG, and CamelBak range from $9 to $35 and could last well over a year (Klean Kanteen 2009, SIGG USA 2010, CamelBak 2010). Consumers fill this reusable water bottle with tap water that costs fractions of a penny per gallon and about $0.49 a year for 8-glasses of water a day (Duffy 2009, Fishman 2007). As a result, there is a relative advantage from adopting this innovation.

Compatibility of the product impacts adoption rates. Sociocultural values and beliefs influence a product's congruency to society and lifestyles (Rogers 2003). Reusable water bottles are typically refilled with tap water; however, Americans tend to criticize the quality of their tap water. There is a widespread misconception that bottled water is healthier than tap water (Fishman 2007). Approximately 47-percent of people consume bottled water on the false pretense that it is healthier than tap water (Duffy 2009). Secondary data indicates that reusable water bottles are currently not compatible with sociocultural values and beliefs in America.

Complexity of an innovation can be a deciding factor in the adoption of an innovation (Rogers 2003). American culture places high value on convenience. The single-use plastic bottle is a grab and go bottle that can be discarded after use, unlike the reusable bottle (Grohol 2007). Users of a reusable bottle may find it tedious to carry an empty reusable bottle around, when a plastic water bottle is more convenient.

Trialability and observability are two perceived attributes of an innovation that effect adoption rates of a product (Rogers 2003). If consumers can try innovations in installments or on their own first, they are more likely to adopt an innovation. Typical consumers are reluctant to espouse new concepts or ideas (Rogers 2003). As a result, it would be beneficial to the reusable bottle industry to allow individuals to try the bottles. Observability ties into trialability. If consumers see other individuals utilizing reusable water bottles, they are more likely to consider adopting the innovation (Rogers 2003). Consumers also must observe the actual impact that single-use plastic water bottles have on the environment in comparison to their reusable counterpart. The more an individual observes reusable water bottles, the higher the likelihood of adoption (Rogers 2003).

The type of innovation decision impacts the adoption rate of reusable water bottles. Currently, the choice to embrace or reject the reusable water bottle innovation is completely optional. However if the adoption process is a collective or authority-driven innovation-decision, perhaps adoption rates could increase (Rogers 2003). In New York, the "Get Your Fill" campaign urged New Yorkers to use reusable water bottles and drink tap water. This campaign mimics the collective innovation decision by the mobilization a majority of the population to use reusable water bottles (Duffy 2009). In San Francisco, the city government made an authority innovation-decision by banning the purchase of bottled water with public funds for city department. Not only will this move save the city $500,000 annually, but it will also force San Francisco public-sector employees to start utilizing reusable water bottles (Duffy 2009, Rogers 2003).

Chapter 3

PLASTIC TOTE BAGS: THE CONSUMER DILEMMA

3.1: Discussion of the Current Problem

From department stores to grocery stores across the United States, consumer demand for plastic bags has increased considerably over the last couple of decades (Plastics Industry 2009). Annually, Americans throw away approximately 100 billion plastic bags (Horovitz 2008). According to the Worldwatch Institute, in 2002, factories manufactured 4-5 trillion plastic bags ranging from large trash bags to plastic single-use shopping bags (Halweil 2008). A large segment of plastic bag production makes up grocery bags, convenience store bags, and other types of shopping bags. Consumers utilize these types of bags because they are convenient, easily transportable, and relatively inexpensive.

Although these single-use shopping bags are relatively inexpensive, their environmental footprint leaves behind quite a different picture. There is an environmental cost associated with the consumption of plastic bags. These bags are made from three basic types of plastic, high-density polyethylene (HDPE), low-density polyethylene (LDPE), and linear low-density polyethylene (LLDPE) (Lajeunesse 2004).

Petroleum and natural gas are finite resources and the main component in the manufacturing of plastic bags. These inputs are major contributors to global issues related to climate change and pollution. At the end of its product life cycle, single-use plastic bags pile up in landfills, taking approximately 1,000 years to photodegrade (Cobb 2008, Horovitz 2008, Jedlicka 2009). Consumer recycling rates for plastic bags also remain stagnant and very low. On the producer end, the economics and environmental benefit of recycling do not align. It costs a producer significantly more capital to reprocess recycled plastic, than to make it out of virgin resins (Arnoldy 2007).

Single-use plastic bags are detrimental to not only the environment, but also to land and marine life. Discarded plastic bags have made their way to oceans, where "they choke, strangle, and starve wildlife and raft alien species around the world, according to David Barnes, a marine scientist with the British Antarctic Survey in Cambridge, England, who studies the impact of marine debris" (Roach 2003, Jedlicka 2009). Numerous reports portray a sobering picture of the detrimental impact that plastic has on land and marine life. Not only do plastic bags clog drainage; they also kill wildlife that ingest plastic. After an animal's body decomposes, the plastic remains, only to be re-ingested by another ill-fated animal (Jedlicka 2009).

Most major retail outlets around the United States offer plastic bags to their customers at no additional cost. According to the Wall Street Journal, retailers spend $4-billion on these single-use plastic bags annually (Jedlicka 2009). Wholesalers such as Costco and Sam's Club do not offer plastic bags to their customers. Stores such as Whole Foods and Trader Joe's offer 100-percent post consumer recycled content paper bags and sell reusable bags (Horovitz 2008). These companies are rare exceptions in a satiated grocery and retail industry that typically offer personalized plastic tote bags made from virgin plastic and with added inks and dyes (Lajeunesse 2004).

Chart II: Scenarios for Plastic Bag Consumption

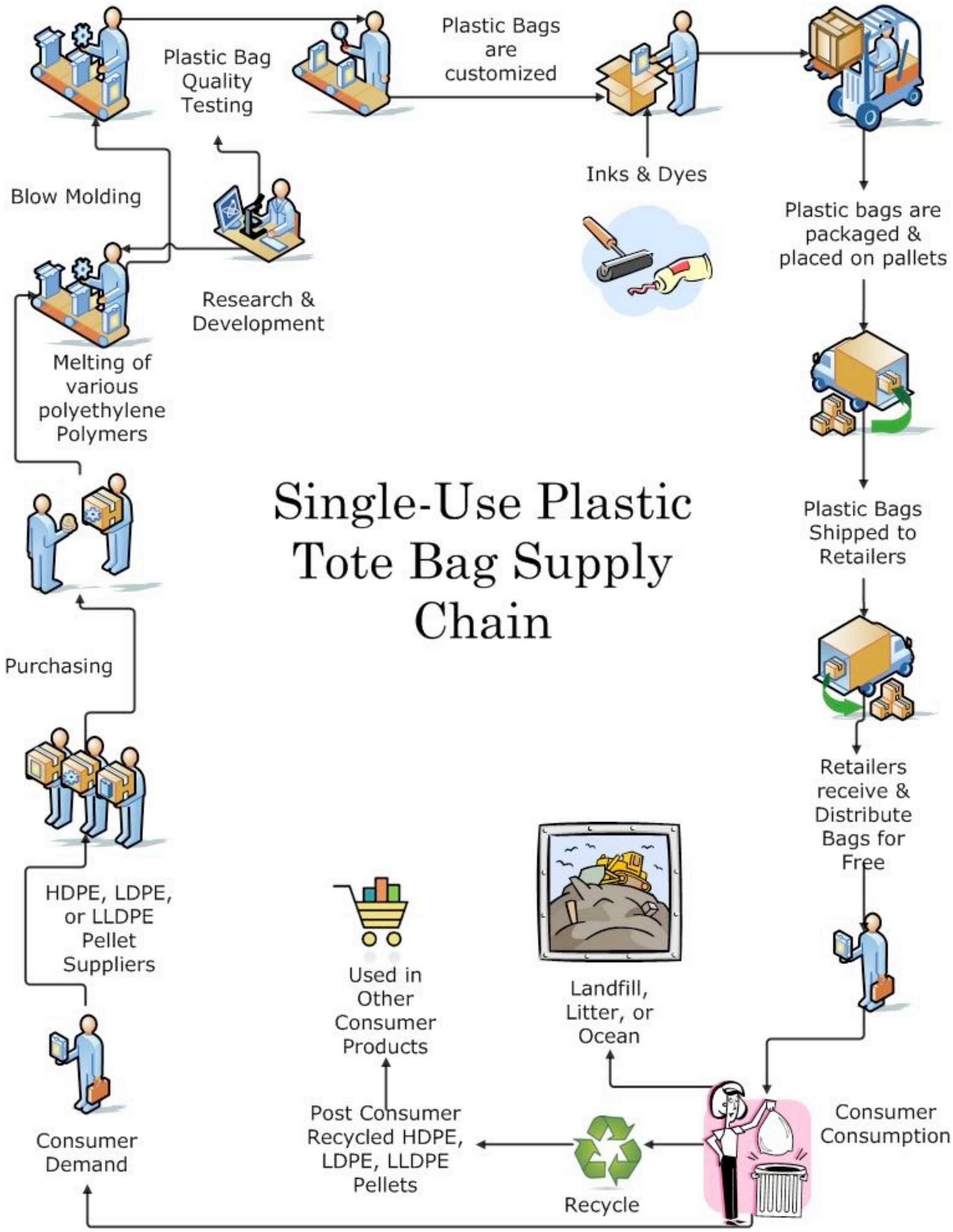
Plastic Tote Bags	Reduce	Reuse	Recycle/Compost	Dispose	Landfill Waste per year
Initial	Reduce double bagging	Reuse bag for groceries or other tasks	Send bags to a recycling facility	Dispose after limited-use	Approximately 326 bags/year
Alternative	Reduce energy and emissions from bag manufacturing	Reuse bag for groceries or other tasks	Send bags to a recycling/composting facility	Dispose after limited use	Approximately 326 bags/year
Substitute	Eliminate use of plastic tote bags	Reuse tote bags multiple times	Recycle /compost cotton, hemp, and recycled-plastic tote bag	Dispose after multiple uses	Less than 1 bag/year*

*Estimate based on Reusablebags.com, three-year life for average reusable bag

The following sections will focus on the scenarios summarized in the chart above. The chart above details the potential footprint that one individual leaves in a landfill, depending on the three consumption options available, the initial, alternative, and substitute. Retailers offer single-use plastic totes to their customers as a convenient way to transport their purchased goods to their final location. All three scenarios depicted above contain a product that serves the same general purpose as the initial single use plastic tote. Within each scenario, the consumer has the option to reduce, reuse, recycle or compost, or dispose of the product. The options leave drastically different externalities on the environment.

Figure II, visualizes the complex single-use plastic tote bag supply chain. The supply chain is driven by consumer demand and continues with the consumer link where consumers make the decisions to reuse, recycle, or dispose the plastic tote.

Figure II: The Supply Chain of Single-Use Plastic Shopping Bag



The supply chain for the manufacturing, consuming, and disposing of a plastic bag is very similar to that of a plastic water bottle. Driven by consumer demand, the single-use plastic bag begins with a mixture of crude oil and natural gas extracted from the earth. The petroleum is converted into pellets of HDPE, LDPE, or LLDPE through a process called Ziegler-Natta vinyl polymerization (Polaski 2010). These pellets heat to 200 degrees centigrade and are pounded until liquefaction. The liquid is blown through an extruding machine into the shape of a bag. Chemical softeners, inks, and dyes are added to the bags for flexibility, color, and personalization. Manufactures cut and seal the bags, adding additional print ads and logos to the bag.

The bags are shipped in bulk via ocean container and truck to retail stores in the United States (Polaski 2010). Consumers purchase goods from retail stores and use the plastic bags to transport goods to their ultimate location. After their use, over 92-percent of Americans reuse their plastic bags for packed lunches, liners for trashcans, and many other tasks (Horovitz 2008). After their reuse, consumers send 97-percent to 99-percent of plastic bags to landfills, leaving 1-percent to 3-percent for recycling (Cobb 2010). The single-use plastic shopping bags will remain in the landfill for approximately 1,000 years before photodegrading into smaller particles of plastic (Halweil 2008, Jedlicka 2009).

3.2: Initial Single-Use Plastic Tote Bag

Americans use and discard approximately 100-billion plastic bags per year (Halweil 2008). This means that in a U.S. population of 307-million people, each individual consumes and disposes approximately 326 plastic bags per year. An overwhelming majority of U.S. retailers offer various types of single-use plastic bags to consumers at no additional cost. These bags are manufactured using HDPE, LDPE, or LLDPE, all of which are contrived from resources that are both non-renewable and finite (Lajeunesse 2004). Manufacturers of plastic bags transport these bags to various warehouses and retailers using fossil fuel powered transportation modes. At their end life, plastic bags clog drainage systems, pollute the landscape, and remain in landfills for years upon years (Jedlicka 2009).

Prior to the introduction of plastic bags in the 1970s, retailers offered paper bags. Today, four of the five bags leaving stores are plastic (Roach 2003). According to Roach, "compared to paper grocery bags, plastic grocery bags consume 40 percent less energy, generate 80 percent less solid waste, produce 70 percent fewer atmospheric emissions, and release up to 94 percent fewer waterborne wastes" (Roach 2003). This efficiency improvement may have promoted retailers to switch to a cheaper plastic alternative. What retailers did not pay attention to was the environmental cost associated with disposing plastic.

Consumers demand plastic bags for a variety of reasons. These bags are waterproof, lightweight, reusable, and available everywhere. Consumers reuse these bags to transport various items such as lunches, gym clothes, and trash (Roach 2003). The Sierra Club estimates that consumers can reuse the average single-use plastic bag nearly 50-times before having to dispose of it (Bushnell 2010). However, a majority of individuals only reuse plastic bags a few times before discarding them. For consumers, single-use plastic bags are inexpensive to obtain and convenient because they can be discarded anywhere for no direct cost.

The consumption of single-use plastic bags leaves a substantial footprint on the environment, from the beginning of the supply chain to the end. The production and distribution of this product is dependent on the use of oil. It requires 35 million barrels of oil for the production of the 100-billion single-use plastic bags that Americans consume every year (Mirkarimi 2007). After the manufacturers produce the bag, they must ship the product to retail stores across the United States. In the city of San Francisco alone, it requires 650,000 gallons of oil to distribute 180 million bags each year (Mirkarimi 2007). If the national plastic bag distribution is similar to San Francisco, shipping bags to retailers burns over 361 million gallons of oil in one year.

After customers obtain bags from retail stores, their negative environmental impact increases. Although, 92-percent of Americans reuse these bags, they still end up in landfills, as litter, or in the ocean (Horovitz 2008). Americans reuse single-use plastic shopping bags only a very limited amount of times before sending 97 to 99-percent for disposal. After disposal, plastic bags remain for about 1,000 years before fully photodegrading. In landfills, plastic bags will photodegrade into smaller plastic particles, microplastics, and mix into the soil and air (Cobb 2010, Horovitz 2008, Jedlicka 2009).

Although there is infrastructure in place at many supermarkets for plastic bag recycling and recollection, consumers recycle only about 1 to 3-percent of plastic bags (Arnoldy 2007, Cobb 2010, Mirkarimi 2007). The bags sent for recycling have an uncertain fate. As discussed in the previous chapter, recycling is well below capacity in the United States. As a result, recyclables are sent to China and other nations with more lax laws for recycling and incineration (Cobb 2010). According to Jared Blumenfield, the director of San Francisco's Department of the Environment, it costs nearly $4,000 to process and recycle just 1 ton of plastic bags. On the commodities market, 1 ton of recycled plastic sells for $32 (Arnoldy 2007). The economics behind plastic bags recycling is inefficient. If the economics do not align, corporations will not want to reprocess and recycle plastics because it is not profitable.

Each year millions of bags end up in the ocean as litter. Numerous studies mention the impact of plastic bags and other plastic products on marine life. Plastics leach toxic chemicals in the ocean, water systems, and rivers around the world (McLendon 2010). According to a 2008 study in the journal *Environmental Research*, 44-percent of all seabirds ingest plastic, sometimes with fatal consequences. The study also states that plastic garbage affects over 267 marine species (Barry 2009). For example, turtles can mistake a plastic bag for jellyfish, a normal part of a turtles diet (McLendon 2010). Once ingested, the animal can choke, suffocate, or swallow toxic chemicals that plastic bags leach.

The largest landfill of garbage is not on land, but rather spread across the Pacific Ocean. Studies refer to this large collection of oceanic trash as the Great Pacific Garbage Patch (Rindels 2009, Barry 2009, McLendon 2010, National Science Foundation 2009). Although its location and size varies depending on the season, scientists estimate that the garbage patch lies 1,000 miles off of the coast of California and is twice the size of Texas (Sohn 2009, National Oceanic and Atmospheric Administration 2010). The Great Pacific Garbage Patch is a swirling ocean vortex with bits and pieces of mostly plastic debris (Erdman 2009). The sun photodegrades the plastic into tiny confetti size particles, into a "soupy mix of plastic-filled seawater that may stretch for thousands of miles" (Erdman 2009). The particles are toxic killers that end up in the food chain. Marine animals of all sizes from plankton to seals and sea birds swallow these plastic bits that contain endocrine and reproductive disruptors such as Bisphenol-A and PS oligomer and carcinogens like styrene monomers (Barry 2009, McLendon 2010, Erdman 2009, Sohn 2009, Rindels 2009).

Not only does plastic leach harmful chemicals, it also acts as a sponge soaking in other toxic organic compounds. Plastics absorb organic pollutants such as polychlorinated biphenyls (PCBs) from the seawater (Barry 2009, McLendon 2010). These pollutants will increase in concentration, as each contaminated animal consumes another contaminated animal along the marine food chain (Barry 2009). At the top of the food chain are humans and scientists are still studying the impact of these dangerous toxins (Sohn 2009, Erdman 2009).

3.3: Alternatives in Plastic Tote Bags

Alternatives to the single-use plastic tote bags are available in the market due to the environmental issues surrounding plastic bags. These alternatives serve the same purpose as the single-use plastic tote bag. The main difference between the initial plastic tote bag and these alternatives is the material composition of these bags. The alternatives are still meant for single-use and maintain the same general convenience of a plastic bag.

BioBag® is a manufacturer of 100-percent biodegradable and 100-percent compostable bags, made from the material, Mater-Bi. The company manufactures the bags with starches containing no genetically modified organisms, a biodegradable polymer, and other various renewable resources (BioBag 2007). The company offers a variety off compostable and recyclable bags including dog bags, cat litterbags, lawn and leaf bags, kitchen bags, and shopping bags (BioBag 2007). All of the bags conform to the Biodegradable Products Institute, ASTM D6400 specification for composting in municipal and industrial composting facilities. The company offers the BioShop bag to retailers around the United States in three sizes and specialty custom sizes. In addition, they offer logo imprinting with soy-based colors. The company touts that whether an individual incinerates or composts the BioShop bag, it still has a relatively smaller impact on climate change in comparison to plastic (BioBag 2007). Trellis Earth Products, Inc. is another company that sells biodegradable bags, however their bags do not conform to the ASTM 6400 standard for compostability. They manufacture a bag made of high quality polymers, starches, and other ingredients. The company claims their bags will naturally biodegrade in a landfill with no toxic residues (Trellis Earth 2007).

Recently, Whole Foods Market ® announced that they would stop providing customers with plastic bags. Instead the company provides customers with 100-percent recycled paper bags and the option to purchase reusable bags for a discount (Horovitz 2008). However, the Whole Foods paper bags are only 40-percent post consumer waste and 60-post industrial waste (Whole Foods Market 2009). In contrast, Duro Bag Manufacturing, Company sells a bag that is 100% post consumer fiber content (Duro Bag 2005). This bag is a more favorable alternative to the Whole Foods paper bag because it uses more post consumer recycled waste.

There are a variety of reasons why consumer adoption of these alternatives is not widespread. The alternatives listed above and available on the market today are significantly more expensive then single-use plastic shopping totes. The bioplastic shopping tote alternative sells for around 7 to 8-cents (Koerner 2007). Trellis Earth biodegradable bags sell for a premium of 9.2-cents per bag (Trellis Earth 2007). Paper bags sell for about 4-cents and the classic plastic shopping bag costs approximately 1 to 2- cents (Roach 2003, Koerner 2007). Retailers and consumers are less likely to adopt a bag that is more costly. The main reason the adoption rate on these bags is low is because retailers do not make these bags available to customers.

Biodegradable and compostable bags require an extensive industrial or municipal composting infrastructure in order to properly breakdown (BioBag 2007, Vidal 2008). Unfortunately, the United States does not have an extensive composting facility infrastructure. In addition, these bags will not break down in at-home composting bins; they must breakdown in industrial conditions (Vidal 2008). Another option is to recycle these bags, however recyclers currently do not have the capacity to recycle bioplastics.

Consumption of these alternatives would still cause consumers to dispose roughly 326 bags per year. The alternatives still follow the single-use concept, thus consumer consumption patterns are unlikely to change despite the change to more environmentally friendly materials. In order for bioplastic bags to replace the tradition plastic bags, it would take significantly more corn, water, and cultivated land (Koerner 2007). As mentioned in the previous chapter, bioplastics may contaminate the recycle waste stream, rendering batches of recycled plastic useless (Cobb 2010, Vidal 2008). In addition, the use of food products such as corn, sugar cane, and wheat in the production of bioplastics may increase the commodity prices of these foods (Van Den Berg and Feinstein 2009). The paper-bag alternative is also inefficient. Numerous articles reveal that the production of paper bags is significantly more energy intensive than plastic bags (Kraft 2009, Koerner 2007). In the production process, these bags emit 70-percent more greenhouse gases than plastic bags (Koerner 2007).

3.4: The Substitutes for the Plastic Tote Bag

Numerous reusable bag alternatives are available to consumers at a variety of retail stores. These bags serve the same general purpose as the initial product and alternatives, however instead of following a single-use concept, these bags are durable enough to be used several times before disposal. These bags have the potential to leave a smaller environmental footprint and are made from a variety of materials including cotton, hemp, bamboo, recycled plastic, compostable plastic, among many other alternatives.

Reusablebags.com is a helpful resource for obtaining sturdy and reliable reusable bags. The company only sells from vendors it approves. The website offers ultra compact bags, string bags, heavy duty bags, thermal and insulated bags, and printed bags in a variety of materials including recycled cotton and organic hemp (Cobb 2010). These bags have a wide price range and are typically biodegradable in a landfill at the end of their use. ACME Bags™ is a notable manufacturer of a large array of reusable bags developed by ReusableBags.com (Cobb 2010). One bag it manufactures is a dual-handled tote made from hemp, a material that is stronger and more durable than cotton; resistant to insect enemies, and 100-percent biodegradable. The company provides a lifetime warranty with all of their bags; thus, the consumer never has to dispose the bag in a landfill (Cobb 2010).

A unique reusable tote is one that is made from recycled materials. Designboom® sells the Let's 'Flexie' totes handmade from recycled vinyl Bollywood billboards that would otherwise be discarded (Design Boom 2010). ChicoBag™ manufacturers the original rePETe™ reusable bag, made from 99-percent recycled content and 73-percent post consumer recycled materials. The bags are durable and machine washable for multiple uses (Chico Bag 2010). Global Goods Partners is a website that sells a variety of products that benefit women in developing nations around the world. Women in developing nations hand make these bags from recycled materials such as rice bags and laundry detergent pouches (Global Goods Partners 2010).

Accustomed to the widespread availability of free plastic bags, a majority of American consumers do not use reusable bags, despite their obvious benefits on the environment (Kraft 2009). Reusable bags are more expensive than plastic bags and bioplastic bags, with costs ranging anywhere from $3.00 to $45.00 (Cobb 2010). Retailers provide plastic totes for no charge. As a result, most consumers have no incentive to switch to reusable bags. Reusable bags also do not have the same convenience as plastic totes available at stores. Consumers must bring reusable tote bags from home to the store.

The environmental footprint that a reusable bag leaves is significantly less than the initial and alternative options. As shown in Chart II, an individual will dispose less than one reusable tote bag per year. The basis of the figure is from the general 3-year life of the average reusable tote. Brands such as ACME Bags™ have a lifetime warranty, so the consumer impact on landfills would be nothing, each year (Cobb 2010). Many of the bags available on ReusableBags.com are 100-percent biodegradable because they are made from 100-percent natural plant fibers such as cotton and hemp (Cobb 2010). Cotton rags can biodegrade in 1-5 months unlike plastics that photodegrade in about 1,000 years (Minnesota Department of Transportation 2009, Jedlicka 2009).

According to the American Chemistry Council, the average American uses 660 plastic bags a year. The production of these bags consumes 336 megajoules of energy. The production of four reusable cotton or polyester totes uses 140 megajoules or 170 megajoules, respectively (Kraft 2009). Using four reusable bags consumes 50-percent less energy than single-use plastic bags. In addition, recycled cotton and plastic reusable bags save more energy because the fiber reprocessing is less energy intensive. Used cotton textiles take only 2.6-percent of the energy involved in making new cotton textiles (Kraft 2009).

3.5: Variables Affecting Adoption of Substitute Innovation

Of the three scenarios, the substitute is the most favorable innovation because it is relatively environmentally friendly and resource efficient. Although the substitute leaves the smallest environmental footprint, consumers are not embracing reusable tote bags for regular use in grocery and retail stores. Five perceived characteristics of reusable bags and the innovation-decision process heavily influences the slow rate of adoption of this substitute. (Rogers 2003).

For the consumer, the relative advantage of reusable bags is lower than plastic bags in an economic perspective. Plastic bags are cheaper than other alternatives for retailers. Thus, retailers provide plastic bags free of charge for consumers. Reusable totes are significantly more expensive for consumers, but elimination of plastic bags can save retailers around the United States to save over $4 billion annually (Cobb 2010). In order for consumers to consider adopting the innovation of biodegradable, compostable, and recyclable reusable bags, the economics of the adoption must be more favorable (Rogers 2003). Incentives can have a profound effect on the adoption of reusable bags by rewarding consumers for a desirable behavior change (Rogers 2003). For example, Whole Foods Market offers its customers $.05 to $.10 cents off of the bill for each reusable bag used (Horovitz 2008). There must be some type of relative advantage available to consumers for this innovation to be widely adopted.

The compatibility of the reusable bag to sociocultural values and beliefs, previously introduced ideas, and the consumers' need for innovation is an important indicator of the products adoptability (Rogers 2003). A majority of Americans do not understand the damage that plastic bags have on marine and animal life (Barry 2009). Based on secondary research, current sociocultural values and beliefs seem to support the use of plastic as a consumable. As a result, reusable plastic bags are not compatible with current societal beliefs. According to Rogers, "potential adopters may not recognize that they have a need for an innovation until they become aware of the new idea or its consequences" (Rogers 2003). Perhaps if more individuals were education on the negative consequences of plastic bag usage, the adoption of reusable bags would be more likely.

For this innovation, complexity is not as important of a variable as compatibility (Rogers 2003). The recyclable, compostable, and biodegradable reusable bag is a simple innovation that is generally not complex to adopt. The reusable bag is more of an inconvenience to Americans, because consumers use free plastic bags. The trialability of the reusable bag is relatively easy (Rogers 2003). If consumers want to trial the adoption of reusing bags, they can bring any type of tote bag with them to grocery and retail stores. The observability component of the reusable bag is important for its adoption. This innovation is particularly easy to observe and communicate to other people (Rogers 2003).

The type of innovation decision drives the adoption rate of the reusable bag. Very few retailers and governments have taken a stance on the detrimental consumption of plastic bags. Consumers that adopt the reusable bag innovation are making an optional and independent decision to do so. The authority innovation-decision is particular influential on adoption rates (Rogers 2003). For example, retailers such as Costco and Sam's Club do not provide their customers with any type of bagging to carry groceries. As a result, customers carry goods individually or bring in reusable bags. In Ireland, the government enacted a 15-cent ($0.20 U.S.) tax on plastic bags. The result of this authority innovation decision is a 95-percent reduction in the use of plastic bags (Roach 2003, Jedlicka 2009). Instead most inhabitants of Ireland carry around reusable tote bags. Although the amount of tax is widely debated, many experts agree that a tax can effectively deter consumers from plastic bags and shift them to adopting reusable bags (Roach 2003, Cobb 2010).

Chapter 4

SUMMARY

All forms of human consumption leave an impact on our environment. Some decisions are more harmful than others. This portion of the thesis summarizes the environmental impact of the initial, alternative, and substitute product for water bottles and shopping tote bags. Secondary data and information is used to substantiate that the substitute innovation leaves a significantly smaller environmental footprint than the initial and alternative products.

Single-Use Plastic, Bioplastic, and Reusable Water Bottles

Chart I: Scenarios for Water Bottle Consumption

Plastic Water Bottles	**Reduce**	**Reuse**	**Recycle/ Compost**	**Dispose**	Landfill Waste per person
Initial	Reduce plastic in bottle	Reuse plastic bottle	Recycle the plastic bottle	Dispose after single use	Approximately 167 Bottles/year
Alternative	Reduce non renewable materials	Reuse plastic bottle	Compost/recycle the biodegradable bottle	Dispose after single use	Approximately 167 Bottles/year
Substitute	Reduce/ eliminate use of disposable bottles	Reuse aluminum water bottles	Recycle aluminum and stainless steel bottles	Dispose after multiple uses	Less than 1 Bottle/year*

*Estimate based on a one-year warranty for product, actual amount varies per individual

Chart I shown above, reveals the landfill impact that each of the consumption options. It also details the potential for consumer actions to reduce, reuse, and recycle in each scenario. The main purpose of the chart is to show consumers how drastically they can reduce the impact their actions leave on the environment by making more conscious consumption decisions. Although the alterative is a more favorable consumption option, the substitute product leaves a significantly smaller impact on the environment.

In the United States, the single-use plastic water bottle is popular because of its convenience and perceived health and purity (Duffy 2009). Each year, Americans consume approximately 50-billion water bottles, on average about 167 water bottles per person, and nearly 1-billion bottles each week (Fishman 2007). Consumption of this magnitude leaves a damaging impact on the environment. Crude oil and natural gas are exhaustible resources used in the manufacturing of single-use plastic water bottles. The pumping, processing, transporting, and refrigerating of the plastic bottle requires 50-billion barrels of crude oil and natural gas (Larsen 2007). Water bottle manufacturers fill their bottles with purified tap water or spring water at a rapid rate, inducing water scarcity (Fishman 2007, Stern 2007). The environmental footprint worsens after consumption. Americans recycle only a small percentage of plastic water bottles. PET plastic recycling rates are so low in America that many recycled bottles are sent to China for reprocessing (Llanos 2005, Environmental Protection Agency 2009). Manufacturers use the majority of the recycled PET for carpets and textiles, not for plastic water bottles (Design Boom 2010). The majority of plastic water bottles clog landfills and take over 1,000 years to degrade (Arnold and Larsen 2006). The bottle degrades into micro plastic and leaches harmful chemicals such as Bisphenol-A into the soil (Ortega 2008).

Single-use bioplastic water bottles are an alternative to the initial plastic water bottle. Companies such as Primo Water Corporation and Green Planet Bottling manufacturer water bottles made from PLA, a compostable and biodegradable material (Green Planet Bottling 2010). According the Primo, the manufacturing process of PLA bottles emits 75-percent less greenhouse gases and uses 49-percent less energy than plastic water bottles (Green Planet Bottling 2010). Although the bottle produces efficiency improvements, bioplastics still leave a heavy environmental footprint. The bioplastic bottles still follow the single-use and discard concept. As a result, if all Americans were to adopt bioplastic water bottles, they would consume 167 water bottles per person and 50-billion bottles per year. This increased consumption could decrease the food supply of corn and ultimately increase the market price of corn (Van den Berg and Feinstein 2009). According to environmentalists, the production of bioplastics will increase the usage of pesticides and fertilizers that pollute the land and water supply (Blanding 2009). These bottles are also only compostable in industrial composting facilities, however the infrastructure industrial composting facilities are not prevalent in the United States (Blanding 2009, Enso Bottles 2009). Consumers that chose to recycle the bottles run the risk of contaminating large batches of other recycled plastics, because bioplastics cannot be readily recycled in current recycling facilities (Llanos 2005).

Reusable water bottles are currently the most viable substitute to single-use plastic water bottles. Reusing water bottles reduces the amount of waste sent to landfills each year to less than one bottles per person per year. These bottles also promote the use of the energy efficient and safe tap water infrastructure available to a majority of Americans (Duffy 2009). Even the transportation of an empty reusable water bottle requires less energy and fuel than a water bottle, which is heavier and requires frequent shipments. A wide array of sturdy reusable aluminum, stainless steel, and BPA-free plastic water bottles are available on the market. Aluminum and stainless steel water bottles are recyclable as inputs for new reusable bottles or other products (Klean Kanteen 2009, SIGG USA 2009). This means that reusable water bottles have the potential to avoid landfills altogether.

Single-Use Plastic, Bioplastic, and Reusable Tote Bags

Chart II shown below, reveals the landfill impact of plastic bags, bio plastic bags, and reusable tote bags. It also details the potential for consumer actions to reduce, reuse, and recycle each type of product. The main purpose of the chart is to reveal to consumers the advantage to the conscious consumption decisions of a substitute reusable product. The initial and alternative send 326 bags to landfills each year, in comparison to less than one for the substitute.

Chart II: Scenarios for Plastic Bag Consumption

Plastic Tote Bags	Reduce	Reuse	Recycle/Compost	Dispose	Landfill Waste per year
Initial	Reduce double bagging	Reuse bag for groceries or other tasks	Send bags to a recycling facility	Dispose after limited-use	Approximately 326 bags/year
Alternative	Reduce energy and emissions from bag manufacturing	Reuse bag for groceries or other tasks	Send bags to a recycling/composting facility	Dispose after limited use	Approximately 326 bags/year
Substitute	Eliminate use of plastic tote bags	Reuse tote bags multiple times	Recycle /compost cotton, hemp, and recycled-plastic tote bag	Dispose after multiple uses	Less than 1 bag/year*

*Estimate based on Reusablebags.com, three-year life for average reusable bag

Americans discard approximately 100 billion single-use plastic tote bags, approximately 326 plastic bags per person, each year (Horovitz 2008). The bags are made from the plastics, HDPE, LDPE, and LLDPE, all of which are derived from crude oil (Lajeunesse 2004). In order to produce 100 billion bags, manufacturers must exhaust 35 million barrels of oil annually (Mirkarimi 2007). Suppliers ship these plastic bags to retailers using fossil fuel intensive transportation modes. Retailers offer these bags to consumers, free of charge typically. Consumers recycle only 1 to 3-percent of these bags after usage, however, the economics behind recycling is not favorable for a recycler. As a result, recyclers ship the bags to China and other developing nations for recycling or incineration (Arnoldy 2007, Mirkarimi 2007, Cobb 2010). The majority of plastic bags end up in landfills, as litter, or in the ocean, where they choke, strangle, and kill marine life (Roach 2003, Jedlicka 2009). In a landfill, plastic bags take 1,000 years to photodegrade into smaller pieces that inevitable contaminate the soil (Cobb 2010, Horovitz 2008, Jedlicka 2009).

Bioplastics offer a unique alternative to the classic single-use plastic tote bag. Manufacturers such as BioBag® and Trellis Earth ™ fabricate 100-percent biodegradable and compostable bags made from bioplastics like PLA (BioBag 2007, Trellis Earth 2007). Baobab's ® production process is less energy intensive than the process for plastic bags. Unlike plastic bags, bioplastic bags are compostable and biodegradable in municipal and industrial composting facilities (BioBag 2007). The United States does not currently have a prominent industrial composting facility network (Vidal 2008). These bags still adhere to the single-use concept. As a result, if all consumers adopted this innovation, they would use on average 326 bioplastic bags per year. In order to meet the increased demand for bioplastics, farmers would have to cultivate, water, and grow significantly more corn to replace the plastic bag (Koerner 2007). Similar to bioplastic bottles, this could increase the market price of corn and increase the use of highly pollutant fertilizers and pesticides (Van den Berg and Feinstein 2009).

The reusable tote bag is an appropriate substitute to the single-use plastic water bottle because it leaves a significantly smaller footprint on the environment. Reusable bags are made from a variety of sustainable materials such as cotton, hemp, bamboo, and recycled plastics. Companies such as ACME bags ™ produce bags that are 100-percent biodegradable and have a lifetime warranty (Cobb 2010). If consumers adopted this innovation, they would contribute less than one reusable bag to landfills each year. Some bags that have a lifetime warranty or are recyclable have the potential to avoid landfills altogether. Natural fibers such as cotton rags only take 1-5 months to biodegrade (Minnesota Department of Transportation 2010). According to the American Chemistry Council, a years worth of plastic bag usage is more energy exhausting than using four-reusable cotton bags. A reusable bag comprised of recycled fiber requires even less energy for production (Kraft 2009).

Chapter 5

KEY INSIGHTS

Both products studied in this thesis have grave consequences on the environment. Although different in functionality, industry, and design, the single-use plastic water bottle and single-use plastic tote bag have many common characteristics. The observations in this thesis result in three key insights, each of which is explained in the following sections. The three insights are (1) plastic is a common offender in water bottles and shopping tote bags, (2) consumption continues despite perceived environmental threats, and (3) it is the important the consumers consider adopting the substitute to avoid further harm to the environment.

5.1: Plastic is the Common Offender in Water Bottles and Tote Bags

Plastic is a material that revolutionized the latter part of the 20th century (Plastics Industry 2009). Although many innovations benefit from its use, plastics used as consumables are harming the environment. The single-use plastic water bottle and plastic shopping tote are both consumables comprised of plastic. Crude oil is a finite and rapidly depleting resource that manufacturers use in the production of plastics. Plastic water bottles are made from PET and plastic tote bags are made from HDPE, LDPE, or LLDPE (AZoM 2010, Lajeunesse 2004). Although the plastic types differ, both products take about one-millennium to degrade in a landfill (Jedlicka 2009, Horovitz 2008, Roach 2003). The degraded microplastic particles mix into the soil, waterways, and the ocean, leaching toxic chemicals. The plastic particles also threaten wildlife and marine life.

One of the most revealing phenomena, the Great Pacific Garbage Patch, exposes firsthand, the negative environmental externalities associated with plastics. As visualized in Appendix E, the Great Pacific Garbage Patch is a vortex of trash located in the gyres of the Pacific Ocean (Rindels 2009, Barry 2009, McLendon 2010, National Science Foundation 2009). This vortex of trash contains mostly plastic debris and litter from human consumption, creating a soup-like mix of plastic filled seawater (Erdman 2009). The plastic bits seep toxic chemicals such as BPA into the ocean and absorb organic pollutants likes PCBs (Barry 2009, McLendon 2010). The chemicals enter the food chain and pose a threat to over 267 marine species. The concentration of pollutants increases as one contaminated animal consumes another contaminated animal on the food chain (Barry 2009). The contamination works its way to the top of the food chain and could potentially harm humans. Although scientists are working on ways to eliminate this garbage patch, it will only truly disappear when humans make changes in their consumption habits.

5.2: Consumption Continues Despite Perceived Environmental Threats

Americans are consuming single-use plastic water bottles and single-use plastic shopping bags at record paces, 50-billion and 100-billion per annum, respectively

(Fishman 2007, Halweil 2008). This mindless consumption is clogging America's landfills, increasing litter, and worsening ocean pollution. Product innovations have opened the door to more environmentally conscious consumption options via alternatives and substitutes. However, a majority of Americans continue to utilize single-use plastic water bottles and plastic tote bags instead.

The slogan, "reduce, reuse, and recycle" adorns numerous products, trashcans, and recycling bins. The slogan asks individuals to reduce consumption, to reuse products that he or she consumes, and to recycle products that can no longer be reused. American consumption patterns have become reliant on disposing and recycling, rather than more environmentally conscious options of reducing and reusing. The substitute products discussed in this thesis promote the reduction of repeated consumption of plastics and the reuse of one solitary product, multiple times. America's current consumption patterns send 40-billion plastic water bottles and 100-billion plastic tote bags to landfills annually (Llanos 2005, Halweil 2008). If all Americans adopted the substitute innovations, they would send significantly less than 300-million reusable water bottles and 300-million shopping totes to landfills each year; respectively 0.75-percent and 0.3-percent of the current waste levels. In addition, toxic chemicals would not enter the soil, waterways, and ocean. Wildlife and marine life would also greatly benefit from the consumption reduction.

5.3: It is Important to Consider Adopting the Substitute

According to secondary data reviewed here, the substitute is the most viable replacement for the single-use plastic water bottle, because it minimizes the environmental footprint that it leaves behinds. Consumers, manufacturers, retailers, and governments must collaborate to change key variables outlined in Rogers' "Diffusion of Innovations" that enable the adoption of an innovation (Rogers 2003).

The relative advantage from adopting the substitute product must increase. Reusable water bottles are more economical that single-use water bottles. For reusable bags, only some retailers have created for incentives for consumers to adopt the innovation. Retailers and manufacturers must create more incentives, increase the economic benefit, and link a gain in social status from the adoption of the substitute. The substitute must also be most compatible with sociocultural views and beliefs, ideas of the past, and the needs of consumers. Consumer perceptions must change in order for the substitute to be fully adopted. Complexity also influences the adoption of an innovation. The two substitutes proposed are relatively easy to use. They require consumers to forgo some convenience and adjust their lifestyle to adopt the product innovation. According to Rogers, trialability can also increase the adoption rate of the substitutes. Consumers should be allowed to trial both substitutes. Lastly, observability plays a role in adoption rates. Consumers that observe and communicate with individuals that use the substitute are more likely to consider the innovation.

The authority innovation decision is an influential motivator that instigates adoption and compliance. The examples cited in previous chapters prove the effectiveness of authority decisions and policies on innovations. For example, local government taxes and bans placed on initial consumables have prompted individuals to switch to alternative and substitute products. For a drastic transformation to occur in

American consumption patterns, governments and other authoritative bodies look to policy as a tool to promote change.

Consumer demand drives production and consumption. A major roadblock for sustainable supply chains continues to be the link to the consumer, where consumers are the decision makers. Consumer actions inevitably determine the fate of the product; whether its consumption is reduced, reused, recycled, or disposed of in a landfill. Plastics, as consumables, pollute the environment, negatively affect health, drain valuable finite resources, and harm animals. American consumption patterns continue despite negative environmental consequences. Consumers should integrate substitutes more readily into their lifestyles. Through reducing consumption and reusing substitutes, consumers will help enable the success of sustainable supply chains.

Chapter 6

LIMITATIONS AND FUTURE RESEARCH OPPORTUNITIES

6.1: Limitations

This thesis was completed using secondary sources of data. It details information, facts, and figures about water bottles and tote bags using publically available published data from a variety of sources. The insights gained from this work are the result of observations of information and data from journals, books, online websites, and other sources. These sources provided valuable facts and perspectives regarding the production, consumption, and disposal of the products. A primary limitation of this thesis was the lack of access to primary data. Primary data would further substantiate the ideas put forth in this thesis regarding the adoption of the innovations.

6.2: Future Research Opportunities

This thesis opens the door to many potential research questions that touch upon facets of consumption, adoption of innovations, sustainability, and pollution, among others. The approach taken in this thesis could be applicable to other consumable products such as disposable paper cups, facial tissues, disposable paper plates, plastic foam plates, and single-use plastic cutlery. Technological innovations and media coverage have motivated scientists to develop alternatives and substitutes to consumption for many consumer-packaged goods. A comprehensive analysis of products like these can help educate consumers and potentially stimulate environmentally responsible decisions for consumption.

A consumer behavior study could also be a useful future research endeavor. The adoption framework discussed in this thesis is based on Everett Roger's "Diffusion of Innovations" (Rogers 2003). The variables and decision models outlined in Rogers' (2003) book could be tested through a comprehensive study of consumer behavior. Questions that arise after completing this thesis work include: Why are consumers reluctant to adopt an innovation that shows obvious benefits to the environment? Are consumers aware of the impact their actions have on the environment? What are current adoption rates for the innovations analyzed in this thesis? What variables must be altered to increase adoption of substitute innovations? What type of policies and incentives can the government and other organizations with authority pass in order for consumers to adopt the substitute? What other products can be classified using the same model developed in this thesis?

APPENDICES

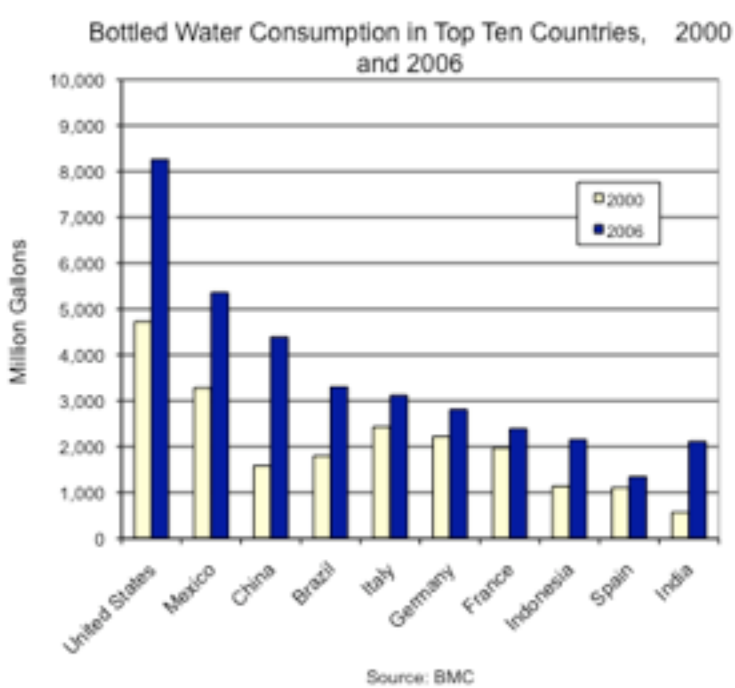
Appendix A: Top Ten Bottled Water Consuming Countries, 2000 and 2006

Country	2000	2006
	Million Gallons	
United States	4,725	8,254
Mexico	3,280	5,360
China	1,582	4,388
Brazil	1,800	3,302
Italy	2,435	3,116
Germany	2,218	2,809
France	1,970	2,394
Indonesia	1,135	2,156
Spain	1,111	1,344
India	568	2,113
All Others	7,735	11,768
Total	28,557	47,002

Note: 1 Gallon = 3.785 liters.

(Larsen 2007)

Appendix B: Graph of Top Ten Bottled Water Consuming Countries



(Larsen 2007)

Appendix C: Long-Lasting Trash (Horovitz 2008)

LONG-LASTING TRASH

Time for materials to break down in a landfill:

Plastic bags	1,000 years
Aluminum cans	80-100 years
Tin cans	50-100 years
Plastic-coated milk cartons	5 years
Orange peels	6 months
Paper	2-5 months

Sources: Whole Foods, Worldwise.com

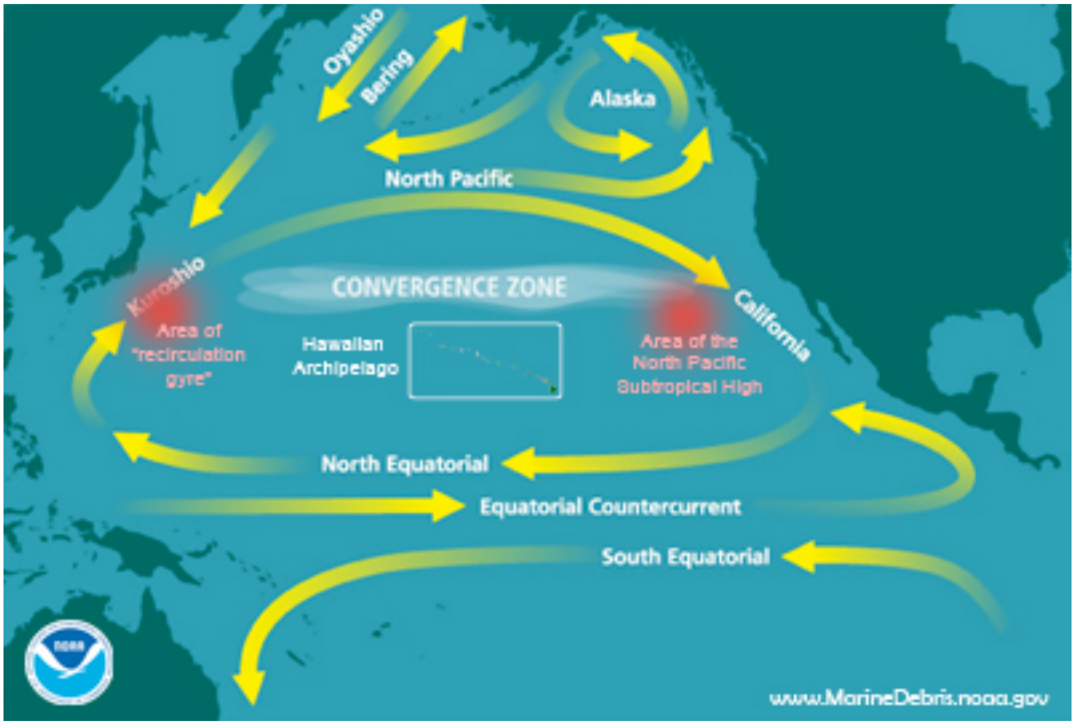
Appendix D: Lifespan of Litter (Minnesota DOT 2010)

Life span of Litter:

Item	Decomposition Time
Glass bottle	1 million years
Plastic 6-pack cover	450 years
Aluminum can	200-500 years
Rubber boot sole	50-80 years
Leather	up to 50 years
Nylon fabric	30-40 years
Plastic film container	20-30 years
Painted wooden stake	13 years
Plastic bag	10-20 years
Plastic coated paper	5 years
Wool clothing	1-5 years
Cigarette butt	1-5 years
Cotton rag	1-5 months
Orange or banana peel	2-5 weeks

Source: *California Waste Management Bulletin*

Appendix E: The Great Pacific Garbage Patch (National Oceanic and Atmospheric Administration 2010)



GLOSSARY OF TERMS

Alternative: A product that provides the same general purpose as an initial product, but is comprised of more environmental friendly materials and processes

Biodegradability: "Susceptibility of a chemical compound to depolymerization by the action of biological agents" (Jedlicka 2009).

Bisphenol-A: An endocrine disruptor used in the production of PET bottles (Erdman 2009).

Closed Loop Supply Chain: "the goal of industrial ecology- moving from I to II to III. *Type I* systems take energy from the environment and dump wastes back. *Type II* has internal process loops so energy and wastes are minimized. *Type III* has closed loops, utilizing wastes as good and running on solar income" (Jedlicka 2009).

Environmental Footprint: the negative externality, side effect, or consequence of the production and consumption of a product

Microplastics: tiny bits, pieces, and particles of broken down plastic through the process of photodegradation (National Oceanic and Atmospheric Administration 2010).

Initial: A consumable product manufactured using unsustainable materials and processes

Polychlorinated Biphenyls (PCB): pre-existing organic pollutants that are toxic to animals (McLendon 2010).

Photodegrade: is the chemical transformation of a compound in to smaller compounds enabled by the absorption of ultraviolet, visible, and infrared light. Specifically, plastics degrade into smaller plastic compounds and particles after the photodegradation process (U.S. Geological Survey 2009).

Plastic Types:

#1 Polyethlene Terephthalate (PETE or PET): a plastic compound typically used in packaging for beverage and food bottles and containers. Common recycled uses include *textiles*, clothing, and carpet; luggage, film, food, and beverage containers (rPET) (Jedlicka 2009).

#2 High Density Polyethylene (HDPE): a plastic compound typically used in packaging for beverage and food bottles and containers; dish and laundry detergent bottle; grocery, trash, and retail bags. Common recycled uses include plastic lumber, pipe, buckets, crates, flowerpots, film, recycling bins, floor tiles; nonfood containers including laundry detergent, shampoo, conditioner, and motor oil bottles (Jedlicka 2009).

#3 Polyvinyl Chloride (PVC or vinyl): a plastic compound typically used in packaging for food and nonfood packaging; medical tubing; siding, window frames floor tiles, and carpet backing. Common recycled uses include packaging, loose leaf binders, decking, paneling, gutters, mud flaps, film, floor tiles and mat, electrical equipment, traffic cones, garden horses, mobile home skirting (Jedlicka 2009).

#4 Low Density Polyethylene (LDPE): a plastic compound typically used in packaging for dry cleaning, bread and frozen food bags, squeezable bottles. Common recycled uses include shipping envelopes, garbage can liners, floor tile, plastic lumber, film, compost bins, trash can (Jedlicka 2009).

#5 Polypropylene (PP): a plastic compound typically used in packaging for food and medicine containers and bottles. Common recycled uses include automobile battery cases, signal lights, brooms, brushes, ice scrapers, oil funnels, bicycle racks, and rakes (Jedlicka 2009).

#6 Polystyrene (PS): a plastic compound typically used in packaging for cups, plates, cutlery, compact disc jackets, egg cartons. Common recycled uses include thermometers, light switch plates, thermal insulation, egg cartons, vents, rulers, license plate frames, foam packing, and dishware (Jedlicka 2009).

#7 other: Often polycarbonate, but also the current designation for any plastic not 1 to 6, such as bioplastics. This plastic is typically used in reusable water bottles, beverage and food bottles. Recycled uses include bottles, plastic lumber (Jedlicka 2009).

Polylactic Acid (PLA): a plastic-like compound derived from corn, sugar cane, and other residuals and mimics clear polystyrene. PLA can be processed like most thermoplastics into fibers or films and can be thermoformed or injection molded (Jedlicka 2009).

Post Consumer Waste (PCW): "This refers to materials that were used for their intended purpose, put into recycling bin, and then recycled into new products" (Jedlicka 2009).

Pre Consumer Waste (Post Industrial Waste): "This refers to scraps leftover from manufacturing, converting or trimming at point of manufacture, cycled back into the materials stream. It may also include unsold magazines and newspapers. Although the paper and scraps are being reused, this paper has never made the journey to the consumer and back again" (Jedlicka 2009).

Recyclable: "This claim means that products can be collected, separated, and recovered from the solid waste stream and used again, or reused in the manufacture or assembly of another package or product through an established recycling program" (Jedlicka 2009).

Recycled: "Recycled claims may be used for products or packaging that contain either pre consumer or post consumer recycled materials. Currently there is no global consensus on what the term 'recycled' means beyond the fact that it may contain either post or pre consumer materials" (Jedlicka 2009).

Substitute: An innovation that attempts to utilize resources and processes efficiently an promotes reuse

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Kimberly-Clark Corporation, Roswell, GA **Logistics Intern** **May 2009 – August 2009**

- Delivered $1.3 million in inventory working capital savings through a global sourcing analysis for gowns
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- Consolidated SKUs that drove $700,000 in inventory working capital savings

Kimberly-Clark Corporation, Chester, PA **Logistics Inter** **May 2008 – August 2008**

- Performed a cost-benefit analysis of an RFID Yard Management tool for a future capital project
- Created and updated over 23 standard operating procedures through a distribution center study
- Collaborated with teams members on implementing an accident prevention technology
- Updated bill of materials information in the SAP system for several spare parts and conveyor equipment

LEADERSHIP:

Treasurer **Smeal Goes Global** **Spring 2009 – Present**

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Business Coordinator **Eco-Car: The Next Challenge** **Fall 2008**

- Worked in a cross-functional team to assist in the innovation of a General Motors hybrid SUV
- Developed a comprehensive strategic business plan for the sale of an environmentally sustainable vehicle

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