UBC Social, Ecological Economic Development Studies (SEEDS) Student Reports

Plastic Bag Garbage Assessment

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Current and Alternative Solutions

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Abstract

The following report describes the current assessment of plastic garbage collecting system at the University of British Columbia. First, it explains the general concepts of the degradable plastic bag and its characteristics with respect to the sustainability. Then, it goes on to the regular plastic bag and finally, the plastic bag-free section. Those three different types of the garbage colleting systems illustrate the environmental, the social, and the economic impacts.

By comparing and contrasting those different types of garbage collecting system at UBC, the reasonable recommendation and solutions can be made as to what would be a good alternative to the current plastic bag being used. The scope of the report is mostly concentrated on the usage of the plastic bags for the garbage bins and the waste containers. Some cost approximations were made in order to approach the alternative solutions.

Table of Contents

1 Regular Plastic Bags

Plastic bags are the common products that people can easily find in the daily life. They are composed of polyethylene, a cheap durable watertight material. Even though plastic bags are made of a very lightweight material, its high tensile strength makes it capable of holding heavy goods. Plastic bags are also re-usable and even remoldable to other products such as plastic lumber, which is used in compost bins, sound barriers, or fencing material. Because of these properties, plastic bags are not only considered as an ideal carrier for goods but also an ideal product to use as garbage bags. However, the manufacturing of plastic bags has become a major source of pollution in the modern age. As people get more concerned about the issues involving sustainability, the production and disposal of plastic bags has become a serious issue. UBC is planning to have a new student union building in 2014 with a sustainable design as a global leader in campus sustainability. Our group has decided to research on possible options for garbage handling on campus to make UBC a safe, healthy and sustainable community. In this section, social, environmental and economic impacts on regular plastic bags (polyethylene plastic bags) will be discussed

1.1 Social Impacts on Disposal of Plastic Bags

Even though UBC has one of the best local recycling systems, it is not possible to control and monitor every individual's recycling habits. Although the plastic bags themselves do not cause social impacts, many side effects are caused by their disposal; for example, bags blocking drains causes flooding, leading to financial and environmental costs associated with cleanup, drain repair, and keeping the area clean. Plastic bag litter is also not visually pleasing. In this part, the impacts of improper recycling procedures will be addressed.

1.1.1 Impacts on Human Health

Plastic bags negatively impact human health because polyethylene, the material that makes up the bags, can last up to 1000 years. Flooding can occur and cause injuries or casualties when plastic bags clog the drains and gutters. In 2005, a massive monsoon

flooded the city of Mumbai, India, which resulted in at least 1000 deaths. The bags were partially to blame in hindering the drainage system, leading to stagnant water, providing the ideal place for parasites to develop and increasing the possibility of an epidemic, such as encephalitis or malaria. Elders and children were especially susceptible to drowning.

1.2 Impacts on Government and Politics

If the regular plastic bags are not disposed properly, high civic expenses may be needed for clean-up process. Money would be spent on removing the plastic bags from the drainage system. Similarly, the cost for removing plastic bags does not stop at the clean-up process: the addition of maintenance costs may be charged to fix other equipment damaged by the bags. These costs will be paid by municipal and national government. To reduce the use of bags, it would be very important to educate the public on the impacts of its manufacturing and careless usage or disposal. Many governments have imposed levies (eco-charge) or the route of taxing plastic bags to reduce the overall ecological footprint (Ellis, 2005). Several actions have already been taken by the government to reduce its usage. For instance, plastic bags are banned in the town of Leaf Rapids, Manitoba, and incentives are offered to consumers who use reusable bags in the City of Sault Ste. Marie, Ontario (Banks, 2008

1.3 Environmental Impacts

Environmental concerns stimulate interest in making a project more environmentally sustainable. The polyethylene bags (the regular plastic bags) are made from crude oil and natural gas and mixed with chemicals as shown in Figure 2 below. The manufacturing process implements non-renewable resources and consequently produces greenhouse gases. Greenhouse gases trap heat and results in global warming. Global warming is primarily caused by carbon dioxide from electricity production and fuel consumption. If the recycled plastic bags are not disposed properly, pollution of plastic bags will accumulate in the land and ocean, damaging the ecosystem. Also, in reality, the portion of the reuse and recycling of plastic bags is small compared to the amount of disposal. Figure 1below shows the life cycle of the plastic bags.

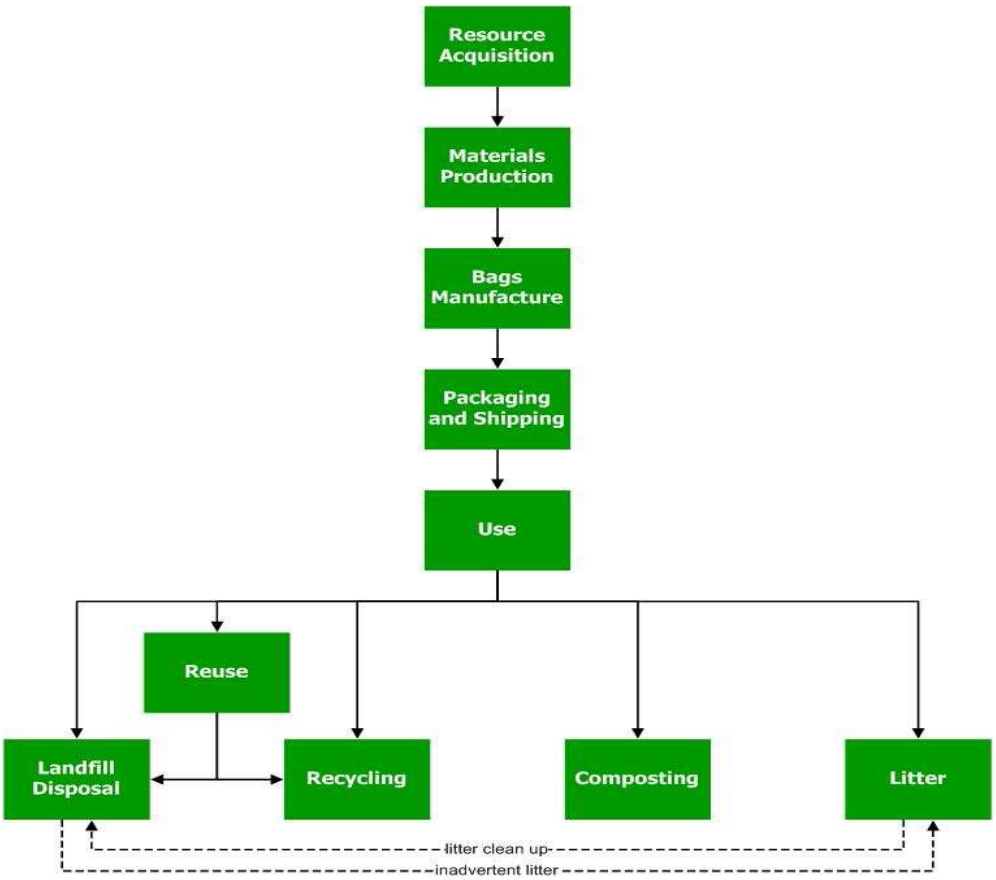

Figure 1: Life Cycle of Plastic Bags

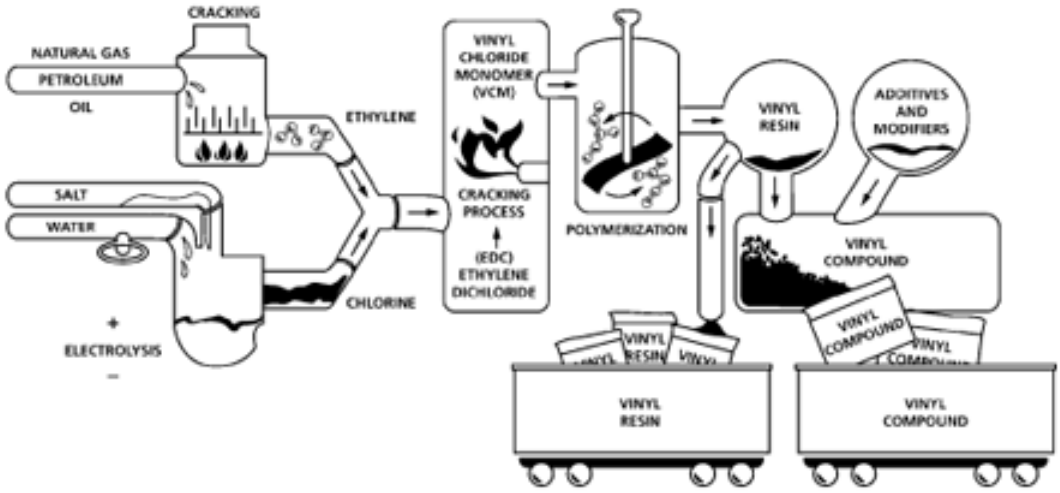

Figure 2: Manufacturing process of plastic bags

1.4 Environmental Impacts on Manufacturing

In the manufacturing process of the regular plastic bags, issues arise on consumption of energy and raw material, and emissions of pollutants and greenhouse gases. In order to produce a regular plastic bag, 0.48 MJ is usually required. Equivalently, one kilometer of car driving consumes the same amount of energy in producing 8.7 plastic bags. Also, from the manufacturing of one plastic bag, approximately 0.5 kg of greenhouse gases is emitted. If 250 garbage bags are annually used in a waste bin at UBC, 125 kg of pollutant is produced per bin for a year (Chadde, 2010). Moreover, additional pollutants are indirectly released from the transporting of the bags, as in trucks and ships. Coincidentally, most of the bags are manufactured in countries where there are few environmental regulations, such as China, thus producing most of the global emissions (Ellis, 2005).

1.5 Environmental Impacts on Disposal

Plastic bags have a lifespan of up to 1000 years because the hydrogen bonds in the polymer are very strong and stable. Most of the used bags end up on land, but remnants of plastic bags can be carried away with the wind and they can end up in rivers or oceans where further degradation occurs by mechanical and chemical reactions. It is reported that 46 000 pieces of plastic exist in every square kilometer of ocean worldwide (Dilli, 2007). The plastic pieces also can threaten the wildlife. If animals mistakenly ingest the plastic pieces, they cannot digest nor passed through their organ so the plastic pieces would stay and can lead to the death. It is reported that in Newfoundland, at least 100,000 marine animals are killed annually due to the ingestion of plastic. Even though their bodies decompose, the plastic pieces do not decompose and can be ingested by other animals (Brown, 2003). UV radiation (295-400nm) breaks the polymer bond of the plastic and the plastic continues to break down to smaller pieces as molecular size. When the plastic is photo–degraded, the brittleness will increase, transparency will be lost, and it can change to a bright yellow color that marine animals can mistakenly consider as food. Moreover, the chemicals used in the process of manufacturing the plastic garbage bags are toxic. DEHP (diethylhexyl phthalate) is used to stabilize the plastic in plastic bags and is known to decrease sperm levels and act as a neurotoxin. Vinyl chloride is also

used in the manufacturing process and it is proven to be carcinogenic and possibly causes liver, kidney, and brain damage (Plastic Bag Economics, 2010). Even though the concentrations of the chemicals used in the production of the plastic bags are low, massive amounts of the plastic bags are produced annually. Since the annual production rate of plastic garbage bags for a manufacturer is about 5000 metric tons, it would lead to serious environmental impacts when remnants of these bags accumulate in land and ocean (Cui, 2010).

1.6 The Economics of Disposal

The low degradability and high durability of the plastic bags make it possible for reuse. However, there would be high labor cost to collect and remold the plastic bags. The price of a regular garbage plastic bag is approximately 7 cents (Supply Ways, 2010). However, there will be more charges on recycling and composting contamination, collection and disposal, street cleaning costs and future municipal landfill liability costs, including post-closure so after purchasing the bags, there would be approximately 17 cents charged per bag. Even though the after-purchasing charge does not contain all of the sources, such as flood control and damage, establishment and operation of programs to collect or process for recycling the plastic bags, people are spending more than double the purchasing price.

2 Degradable Plastic Bags

Degradable bags fall into a few categories: degradable, biodegradable, and bags that require light or oxygen to degrade. These terms are defined in ASTM standards on plastics. The principle difference between degradable and biodegradable is that biodegradable bags must decompose completely to carbon dioxide and must not negatively impact plants that are grown in soil that has had bags biodegrade in it. Degradable bags need only lose their physical properties and are permitted to remain as small pieces of plastic.

Currently UBC uses green Buffalo Bag degradable bags. The manufacturer claims that these bags are degradable in some settings and biodegradable per ASTM D6954-04, however they were unable to supply test reports indicating conformance to this standard.

Buffalo Bags are composed of approximately 95% LDPE, the other 5% containing additives and Trioxo-d(Environmental Plastics Inc, 2007), the additive claimed to cause the degradability. This means that the environmental impacts from the production of the bags may be assumed to be the same as an equivalent normal bag produced from LDPE.

Test reports were requested from Buffalo Bag to verify compliance with ASTM D6954-04 (Environmental Plastics Inc, 2007), however the test reports provided do not indicate this. ASTM D6954-04 has a requirement for the residues from the degradation process to be tested for impacts on seed germination and microorganism reproduction, steps that were lacking in the manufacturer provided documentation. From the documents provided it can only be concluded that the bags are degradable, not biodegradable. It is possible that they are biodegradable in some settings but this cannot be determined without additional testing.

2.1 Social Impacts

There are minimal social benefits associated with degradable bags. There is some prevention of litter produced when any stray bags will degrade within 12 months however it can be expected that there will be few bags that escape the waste stream at

UBC. Overall, the social impacts can be regarded as being identical to that of non-degradable bags.

2.2 Economic Cost

Cost data for the bags that UBC uses was not available. It can be expected that the costs are an increase over non-degradable plastic bags.

2.3 Environmental Impact

As the bags used by UBC do not biodegrade and only degrade, the environmental impact is essentially identical to that of non-degradable bags. At 17g of LDPE per bag and 250 bag changes per year there is a production of 11.29 kg CO2 greenhouse gas equivalent and 4.7g of phosphate release to the environment.

3 Plastic Bag-free Garbage Collection

The following sections listed below are different types of the plastic bag-free garbage collecting system. The usage of the washing bin system and the reusable garbage bag are described.

3.1 Washing bin system

Currently, UBC is using degradable plastic bags for the garbage collection. Each building at UBC has garbage cans indoors that use these garbage bags. The custodial staff collects those bags every day, replace them with fresh empty bags, and place the full bags in a large dumpster outdoors. Then UBC Waste Management trucks pick up all of those full garbage bags from the dumpsters and send it to the landfill

In order to switch to a plastic bag-free garbage collecting system, the following need to be considered: designing a new container for garbage, designing a new garbage truck, and hiring a new staff.

Since the normal indoor cylindrical bins are not suitable for being carted outside, the new design of the bin is considered, for example, attaching the cover so that it can prevent the animals' approach. In terms of designing, the bins should only be removable by custodial staff and not to the public individuals. In addition, UBC's current garbage collection truck is designed to only pick up large dumpsters and not 35L bins so if bins were to be removed by machinery a new truck would need to be designed

In the UK, the company called "Green Cleen" is involved in cleaning the domestic and commercial bins. The company operative uses high-pressure lances that wash out the dirty bins. The machines then recycle all the used water and dump the wastewater at the registered site at the end of the day. As the washing is progressed, one hundred percents of biodegradable chemicals make the whole process environmental. The company charges £3.5 per bin, approximately $5.25 at current exchange rates.

3.1.1 Social Impact

If the garbage collecting system were to be changed to the bin washing system, there would be a small number of additional jobs created at UBC to wash and collect the 3000 bins per day. It is possible that accommodating the washing bin system brings a negative impact to the plastic bag company, as plastic bags would no longer be utilized to collect the garbage.

3.1.2 Economic Cost

The economic cost of using the washing bin system is described in Table 1, which shows the cost of purchasing new 35L bins and trucks and the operating costs associated with switching to a plastic bag–free garbage collection system.

Table 1: The life-cycle financial cost of the washing bin system

Operating Cost	Units/week	$/year	One time costs
Electrical consumption for bin washing machine	32	200	
Water consumption for bin washing machine	32	500	
Facility maintenance		2 000	
Designing a new truck which can pick up 35L bins			3 000
Designing new bins which can be carted			300
Bi-annual compost quality testing		500	
Max Pro Detergent for washing bins	4	1 300	

Equipment and Vehicle Costs			
Buying new bins	3 000		285 000
Buying a new truck	8		160 000
Gasoline consumption		4 610	
Actual gasoline usage collected		12 959	
Vehicle Maintenance		500	
Total Cost		22 569	448 300

3.1.3 Environmental Impact

As it is shown in Table 1, purchasing the truck and paying for the electricity and water usage are part of the economic impact of using bin-washing system. However, they can also be considered as an environmental impact since there will be material and energy consumptions when the truck is created.

In addition, the problem of water shortage might arise since the large amount of water will be used assuming that 3000 bins get washed and cleaned every day

Moreover, more amount of electricity will be needed to run the bin washing machines compare with the usage of degradable plastic bag system. When the electricity is generated from the coal-power plants, it will provide a negative effect to the environment because burning coal in power plant to generate electricity is most harmful to air quality due to the emissions of carbon dioxide and methane.

The specific quantitative values of water and electricity usage from current UBC washing machine were not provided to the students; however, there will be a significant increase of water and electricity consumptions when the plastic bag garbage collection system is switched to the washing bin system.

3.2 Reusable Bag

As many people believe that plastic bags have a strong negative environmental impacts many people have tried using natural resources such as wool, bamboo, tree bark, sea grass, banana leaf and coconut fiber to make more environmentally-friendly reusable garbage bags. Since these products are made from natural resource they will biodegrade back into soil.

Despite the fact that the material is natural, once it comes to mass production due to the high demand, it becomes no longer sustainable since more environmental damages are caused. Therefore, the consumer needs to limit and minimize the harm they cause by buying the most ethically produced bag out there which means buying the product from the sellers who exactly know how and where the bags are made. In addition, it is incredibly difficult to find the environmental products that are cheap since few chemicals are added and used which means the product yields are reduced and take a long time to grow.

If the reusable bags that are made from non-disposable material like a cloth are used 11 times, then they will have less environmental impact compare with manufacturing 11 disposable bags. The reusable bags cost very little and yet they can be used for more than a hundred times. The reusable bags can be recycled at the local clothing recycling facilities when they are completely worn out.

4 Conclusion

4.1 Traditional Plastic Bags vs. Degradable Plastic Bags

As the degradable bags currently in use by UBC do not biodegrade in a landfill it is recommended that their use be discontinued and new bags selected on the basis of cost and the thinnest wall thickness while retaining sufficient strength to not break while being used to carry garbage.

4.2 Begin Design Work on a Bin Washing System

At $0.17 per bag and 250 bin changes per day for 3 000 bins the traditional bags cost a total of $127 500 per year, an increase of $104 931 over a bin washing system, causing the bin washing system to repay the initial investment after 4 years at a 5% interest rate.

Preliminary design work should be started on a bin washing system to investigate the costs and water usage required in greater detail. After this work is completed a detailed comparison on the environmental impacts should be completed.

Bibliography

ASTM International. (2004). Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation. *D 6954 – 04* . ASTM International.

ASTM International. (2008). Standard Terminology Relating to Plastics. *D 883 - 08* . ASTM International.

Buffalo Bag. (2010). Buffalo Bag Packaging.

Environmental Plastics Inc. (2007). *Degradable Polyethylene Garbage Bags*. Test Report, Vancouver.

Hosking, R. (n.d.). *Plastic Facts*. Retrieved March 24, 2010, from Modbury, South Devon: Great Britain's First Plastic Bag Free Town: http://www.plasticbagfree.com/facts.php

Township of Aylsham in Norfolk. (2010, January 17). *Aylsham Plastic Bag Free*. Retrieved March 27, 2010, from Aylsham, Norfolk's FIrst Plastic Bag FREE Town: http://www.aylshamplasticbagfree.co.uk/

Baker, R. "Ministerial Brief: Plastic Bag Levy". The Austrailian National University. March 28.2010 Banks, Sam N. K. “Plastic Bags: Reducing Their Use Through Regulation and Other Initiatives”. Industry, Infrastructure and Resources Division. 8 Dec 2008

Dilli, Rae. "Comparison of Existing Life Cycle Analysis of Shopping Bag Alternatives". 18 April 2007

Chadde, Joan. "Michigan Tech". Michgan Environmental Education Curriculum. 28 March 2010. <http://techalive.mtu.edu/meec/module14/Conclusions.htm>

Cui, Maria. "Global B2B Market Place". EC21. 28 Mar 2010 <http://www.ec21.com/product-details/Garbage-Bags--3337832.html>

Ellis, Sara. “Plastic grocery bags: The ecological footprint”(2005)

Haley, Robert. "Costs Associated with Paper and Plastic Bags". Department of the Environment. 28 March 2010 <http://www.mindfully.org/Plastic/Bans/Costs-Paper-Plastic-Bags17nov04.htm>

Banks, Sam N. K. “Plastic Bags: Reducing Their Use Through Regulation and Other Initiatives”. Industry, Infrastructure and Resources Division. 8 Dec 2008.

Appendix A: Test reports from Buffalo Bag