UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Life Cycle Analysis of Bags for Food Scraps Collection

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<u>Life Cycle Analysis of Bags for Food Scraps Collection</u>

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Abstract

This report analyzes three alternative composting systems to improve sustainability for the UBC composting system: switching to an off-site composting facility, replacing plastic bag liners with paper bags and switching to a bagless system. The evaluation was done by performing a triple bottom line analysis on each of the options based on the information acquired from the client Bud Fraser as well as information from online resources such as the SEEDS library. Upon examination, the results indicate that the bagless system is the most viable out of the three options. The bagless system can be integrated into the current composting system with very little effort, which saves a large amount of integration time to fully implement the system. It will allow for zero bag waste and, in comparison, a minimal amount of further waste in the form of fuel and water. It may be the most cost effective and the least disruptive solution to the current system, however the downsides to this solution are specifically social, such as custodian staff lifting heavier loads and trucks transporting bins more frequently. In the future, the findings of this report could be further used to develop an even more sustainable system of composting.

Table of Contents

List of Illustrations

List of Figures

List of Tables

1.0 Introduction

UBC, in collaboration with the University Neighbourhoods Association, has developed a Zero Waste Action plan which aims to reduce waste production on campus while also reusing as much of the unwanted resources through a recycling process (Ma, 2015).

Waste on UBC campus can be categorized into following categories: paper, plastic, organics, non-recyclables and others. Based on the 2010 waste audit, it has been shown that more than half of the wastes produced on campus is organic materials (Figure 1), all of which currently goes directly to the UBC on-site composting facility. However, the plastic garbage bags that are currently being used to collect organic materials cannot be processed by the composting facility and as a result, they are thrown out with the regular garbage. The problem with this method is that it produces unwanted plastic waste which conflicts with the Zero Waste Action plan.

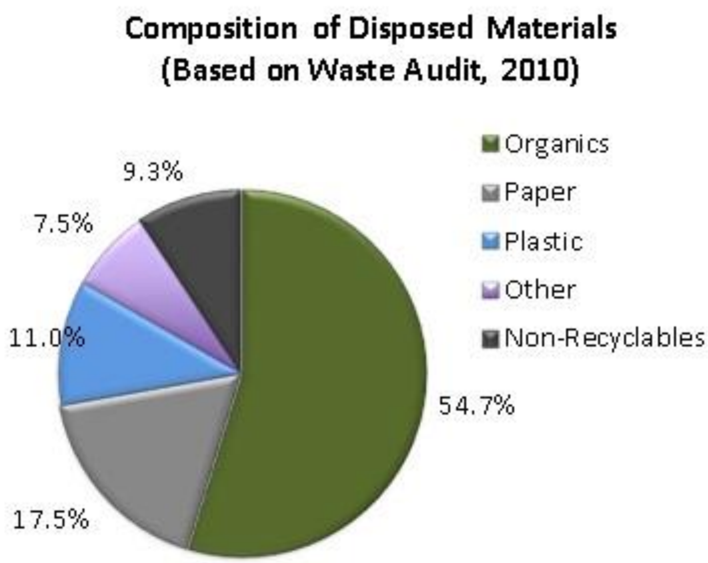

Figure 1: UBC waste composition in year 2010

This report analyzes the alternatives of the current composting process such as using an off-site composting plant, using paper bag liners and adopting a bagless composting system. This report then proposes a solution based on the feasibility of each composting method which has been assessed using the Triple Bottom Line analysis as the main guideline.

Our methods of research include gathering information from scholarly articles, the UBC SEEDS library and speaking to the client in-person and through e-mails.

2.0 Analysis of Existing System

The current composting system used by UBC can be divided into four stages: waste collection, transportation, composting and bin washing (Figure 2). In the first stage, the plastic bag liners are removed and replaced from the recycling stations (Figure 3). The contents of the plastic bags are then emptied into a larger plastic container and the plastic bags are thrown into regular garbage bags. In the second stage, the large plastic containers are loaded onto a truck which then transports all of the organic wastes to the UBC composting facility. In the third stage, the contents of the plastic bins are further examined to ensure all of the materials are safe and applicable for composting. In the final stage, the plastic bins used to transport organic waste are washed at the UBC bin washing stations and are prepared for transportation back to the designated recycling stations.

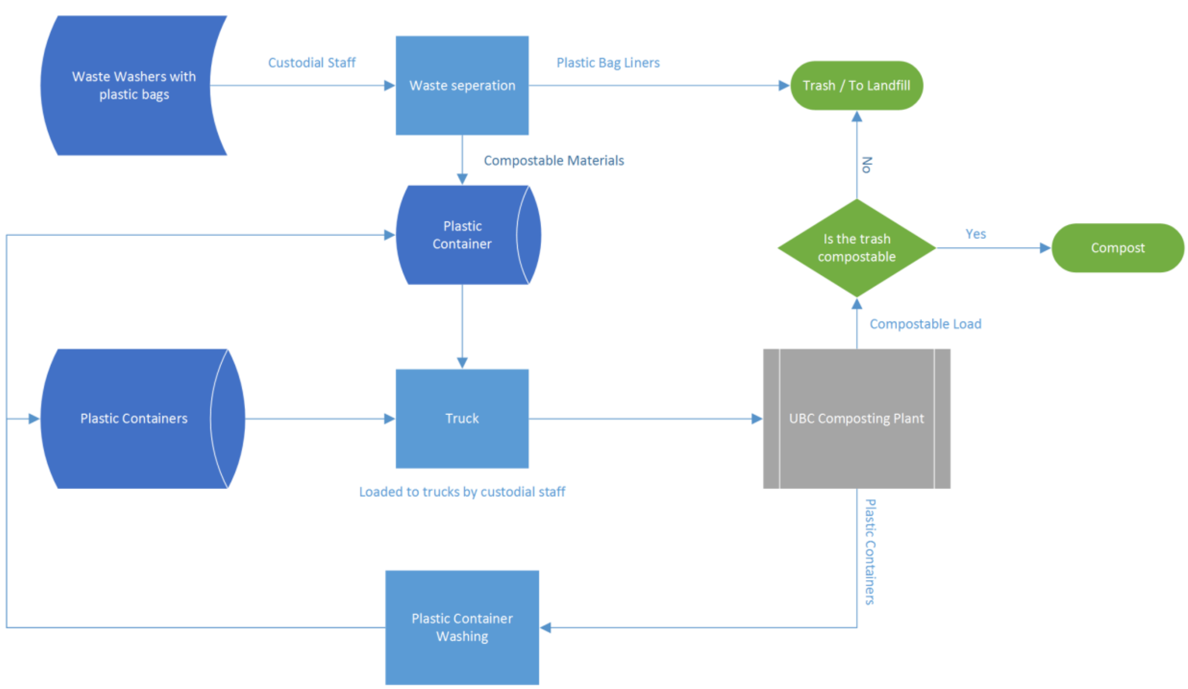

Figure 2: System diagram of current UBC composting system

Figure 3: UBC recycling and "Waste Watcher" station

One of the main notable problems with the existing system is the use of plastic bag liners. Regardless of whether the bag is compostable or not, the bags do not decompose fast enough for it to go through the composting machines available at the facility without getting stuck in the machine. As a result, the bags are separated from the organic wastes and are treated as regular garbage. Approximately 450 recycling stations are currently stationed throughout the UBC campus, and the plastic waste resulting from the bag liners add up to a significantly large amount. Therefore, we have considered three alternative options to using plastic bag liners starting with the use of off-site composting plants.

3.0 Off-site Composting System

The first feasible solution is to change the current UBC system by replacing the processing of waste on-site to transporting the waste to a third-party off-site composting plant. Although it is a big change from the current system, most of the processes such as waste collection and waste transportation are done in a similar fashion. The following sections will thoroughly analyse the benefits as well as the disadvantages to this solution.

3.1 Solution Description

For this solution, the standard gathering procedure is described as follows. The custodians will still go around the campus and collect compostable waste in the plastic liner bags from the Waste Watcher bins around the campus. Then, the collected waste will go directly into a transport truck inside large plastic containers and the Waste Watchers will be reloaded with a new liner, which completely omits the trash separation step which exists in the current system. The truck will then be transported to a third party composting site and the big plastic containers will be brought back to the cleaning station afterwards for cleaning and recirculation.

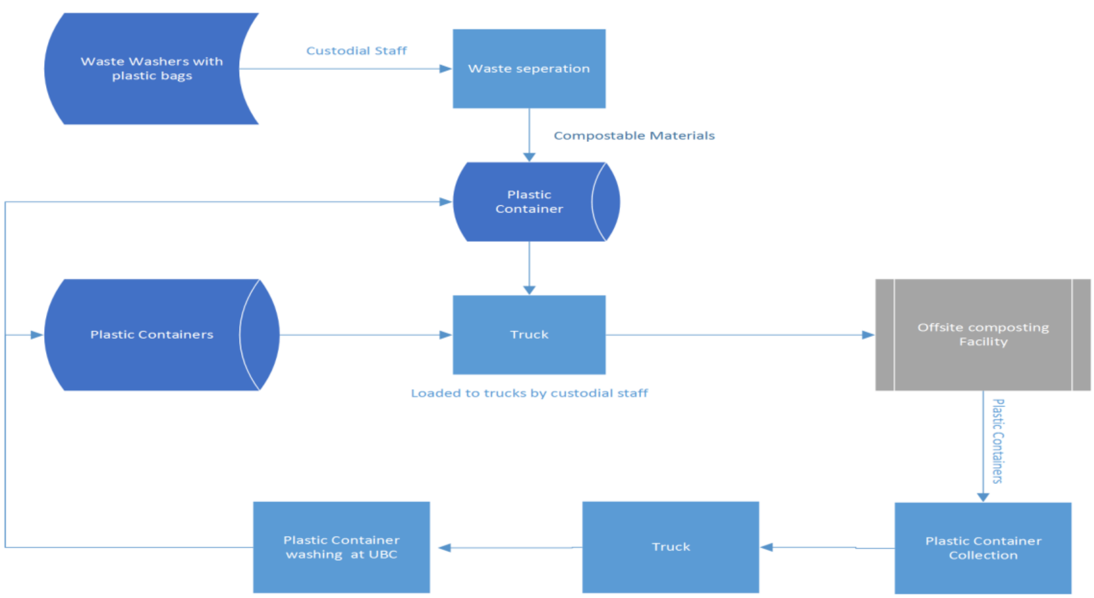

Figure 4: Off-site solution flow chart

3.2 Advantages and Disadvantages

The off-site composting solution contains advantages in all three categories: financial, environmental and social. Financially, UBC will be able to save a large amount of labour costs if the garbage was collected directly from each station/building and sent to an off-site plant without sorting the waste to remove any plastic. According to our client, there is always someone at the UBC plant monitoring the load input to make sure there is no plastic entering the system. Also, if we sent all of our compost to an off-site plant, the only associable cost would be service fee per ton of compost charged by the third-party composting plant as well as the transportation fee for transporting the compost to the off-site plant. Costs for stationing a garbage separator and running the whole plant can be omitted. Environmentally, this solution allows the off-site plant to operate at a higher efficiency. Efficiency can indicate a few things other than operational costs per ton of compost processed. For example, the environmentally damaging agents that are used to help treat compost will be used at a more efficient rate, thus making a positive environmental impact compared to treating at a smaller plant. Socially, this solution benefits the custodians by simplifying their task to just simply garbage collection and reloading the liners in each Waste Watcher.

Although this solution has a lot of advantages, it has some environmental and social disadvantages. Although it has been previously discussed that the waste will be processed with higher efficiency, one must consider the greenhouse gases produced when transporting wastes over long distances for the environmental analysis. For the social analysis, it does make the custodian's job much simpler, but having a third-party processing plant process the waste will make the UBC compost plant totally unnecessary. Thus the decrease in potential long-term career positions might affect the custodians or even the garbage separator staff to go work somewhere else.

3.3 Triple Bottom Line Analysis

The triple bottom line analysis for this solution will consist of evaluating economic indicators, social indicators, and environmental indicators that relate to using a third-party off site composting plant. The following indicator will be listed in bullet point form below in order to summarize each indicator in a short description.

Economic Indicators:

- Cost of labour:
    - The cost of overall labour on site will decrease significantly as the required tasks are simplified to just garbage collection and garbage transportation.
- Cost of operating composting plant:
    - Cost of operating the UBC composting plant can be negated. By sending compost to a bigger, much more efficient plant, compost can be treated with a lower cost per ton rate.
- Cost of service:
    - There will be an additional cost for having a third party composting plant accepting our compost.
- Cost of transportation:
    - There will be an additional cost for transporting our garbage to an off-site plant compared to just transporting them to the UBC on-site plant.

Social Indicators:

- What composting materials do the facilities accept?
    - This is the biggest problem of this solution. After researching for the facilities in the Greater Vancouver, none of the sites accept any variations of plastic including biodegradable plastic. This information jeopardizes the validity of the entire off-site solution.
- How much labour is involved?
    - As mentioned before, overall on-site labour will be decreased.
- How will be the custodians and the facility workers be effected?
    - Some of the staff will lose their jobs since compost will be sent to a third-party composting plant.

Environmental Indicators:

- Amount of GHG (Greenhouse Gases) released:
    - Although processing compost at a larger more efficient plant can decrease the overall GHG released in the process of composting, there will be an increase of GHG released due to transporting waste over longer distances on vehicle.
- How many resources are used in the composting process?

- Overall resources will be reduced at a larger more efficient processing plant.

Overall, the indicators for each TBL category show that this solution could be a reasonable option. However, one of the social indicators, specifically the one about accepting types of compost material, blocks this solution from being practical. Because all the processing plants in the area that were researched do not commercially accept any variations of plastic, this solution is impossible since the entire purpose of this solution was to decrease labour by eliminating the plastic-filtering process from the waste.

4.0 Paper Bag Bin Liners

The second feasible solution is the implementation of paper bag liners as a replacement for the current plastic bag liners. Replacing plastic bin liners with paper bag liners may seem fairly straight forward, easy to do and contributes to less GHG emissions. However, our detailed analysis shows that several social and economic consequences arise if UBC decides to use this solution. The following sections describes this solution in more detail, its advantages and disadvantages, and presents a triple bottom line analysis of implementing the solution.

4.1 Solution Description

Describing this solution is simple; instead of lining the compost bins with plastic bags, we use compostable paper bags. There are a variety of paper bag sizes that are available in the market for residential compost collection and for yard trimmings use. We are interested in how this solution might work with the medium and large sized bins since these sizes consist of most of the waste watcher bins on campus. Given that there are plenty of products out there in the market already, we are more concerned on how well the compostable paper bags can be adapted to the current system.

By using compostable paper bags, the everyday tasks of the janitorial staff would not see that their day-today jobs are completely changed, but it will make a significant impact on the tasks they repeat every day. First, the staff would have to make more trips to the storage room since they would be carrying less bags than they did if they were plastic since the volume to unit ratio of paper bags is significantly higher. Then, the staff would have to spend about a minute at most unfolding each bag, placing the bag in the bin, and securing the bag so it would fit in the bin properly. Also, to prevent food scraps from slipping between the bag and the bin, the bag would have to be sealed to the bin by using tape or some other mechanism that would introduce a new product in the process. On top of that, the management would have to take into account the new price for compostable paper bags, which could affect how carefully the janitorial staff handle the bags.

The following section will describe how these changes in the janitorial tasks either create an advantage or disadvantage towards implementing compostable paper bags as bin liner.

4.2 Advantages and Disadvantages

The main and clear advantage of using a compostable paper bag is that it is indeed compostable and that it is an acceptable material in the current UBC composting facility. This is important since compostable plastic bags are not allowed to be composted at UBC. This is due to the fact that they easily get caught in the machine's spindle which results in the machine stopping unexpectedly and requiring more maintenance work than what's usually expected. When feeding compostable paper bags into the machine, the machine is not affected and continues to operate normally as if the paper was regular food scraps being processed.

Even though compostable paper bags have a major advantage, the number and severity of the disadvantages outweigh the single advantage. These disadvantages include high prices, lack of flexibility, high volume per unit ratio and more labour time required. Compostable paper bags are at least twice as expensive as plastic bags per unit and take up significantly more space per unit as well. This is summarized in the table below.

Table 1: Paper bag size and price comparison

Description	Single Unit Size (L)	Quantity	Price (w/o tax)	Per unit price
Plastic Bags (current system)	(140)*	125	$24.65	$0.20
Bag to Earth, 20 pack	5.51	20	$12.98	$0.65
Home Depot, Kraft Paper Yard Waste Bags, Bag to Earth	110.12	5	$2.28	$0.46
Rona, Pack of 10 Compostable Bags	110.12	10	$4.49	$0.45
Rona, Bag to Earth 5 pack, large bags	34.61	5	$7.49	$1.50

* Bag capacity is 140L given that it can fit the largest bin. However, the amount of space it occupies is very small compared to a single paper bag.

With a higher price per unit, the cost of implementing a compostable paper bag system for bin liners across the entire UBC campus is very high and very unattractive. The paper bags are also very inflexible as observed when handling the current product in the market. They always have to be unfolded and the bags themselves can never line up exactly over the edge of the bin. In terms of flexibility, plastic bags have an obvious advantage over paper bags. The fact that paper bags are inflexible also creates an impact on the amount of time spent setting up a single paper bag in a compost bin. From experience, we've seen that it takes up to at least 50% more time to set up a single paper bag in a bin as compared to a setting up a single plastic bag in a bin. That means 50% more of the available working time that could be used for setting up bags for the bins is wasted due to the fact that is takes longer to do it when using a paper bag. This time loss also translates into an economic loss since a time loss translates into an additional of labour.

Having analyzed the advantage and many disadvantages of using compostable paper bags, the following section will translate this into a clear cut triple bottom line analysis.

4.3 Triple Bottom Line Analysis

The triple bottom line analysis for this solution will consist of evaluating economic indicators, social indicators, and environmental indicators that relate to compostable paper bag liners. The following indicator are listed and described in bullet point form below in order to summarize each indicator in a short description.

Economic Indicators:

- Cost of labour and maintaining the composting facility:
    - The cost of labour will increase as more labour time is required to setup individual paper bags in bins. However, this will have affect on the cost of maintaining the composting facility due to the introduction of paper bags.
- Cost of processing compost:
    - There might a very small cost in adding paper bags to the composting system due to the fact that more compost is now being processed because of the added mass of the paper bags, however this is expected to be insignificantly small and can be essentially neglected.
- Cost of bags:

    - Paper bags will cost at least twice as much as plastic bags, therefore creating a significant additional cost for operations.

Social Indicators:

- What composting materials do the facilities accept?
    - The UBC compost facility does accept compostable paper bags at no additional maintenance costs or risk of shutting the machine down.
- How much labour is involved?
    - Paper bags are very rigid and lack flexibility, therefore janitorial staff will have to use at least 50% more time in order to unfold a single bag and set them up in individual bins. Unfolding bags is not physically demanding, however the weight of a large quantity of bags is significantly greater compared to a large quantity of plastic bags, which pose the risk of injury due to lifting a large amount of bags.

Environmental Indicators:

- Amount of GHG released:
    - Since the paper bags are being used, the GHG emission is less than disposing of plastic bags to the garbage. The additional compostable material added to the compost processed does not significantly impact the amount of GHG emissions released due to the composting process.
- How many resources are used in the composting process?
    - The additional resources used due to the new paper bags, such as additional labour and time, do not have any known environmental impact. Therefore, no resources are used that would impact the environment directly.

Overall, the indicators for each TBL category show that this solution is not very practical and very costly despite its environmental benefits.

5.0 Bagless System

Our third feasible solution, a bagless composting system, is a promising solution. In this proposed solution, the bins will not be lined and therefore the users will dispose of the compost into the larger compost bins directly. To accommodate this, the workflow of the custodial staff will be adjusted. Rather than moving bags of compost to the facility, now the entire Waste Watcher compost bin will be taken to the compost facility for processing. The staff will move the Waste Watcher bin to the truck and place a replacement bin in the corresponding Waste Watcher station. The truck would be driven to the composting facility where the content of the bins would be dumped onto the processing line and the bins would then be washed. The washed bins would then go back into circulation. A high level system diagram of this design is shown in Figure 5.

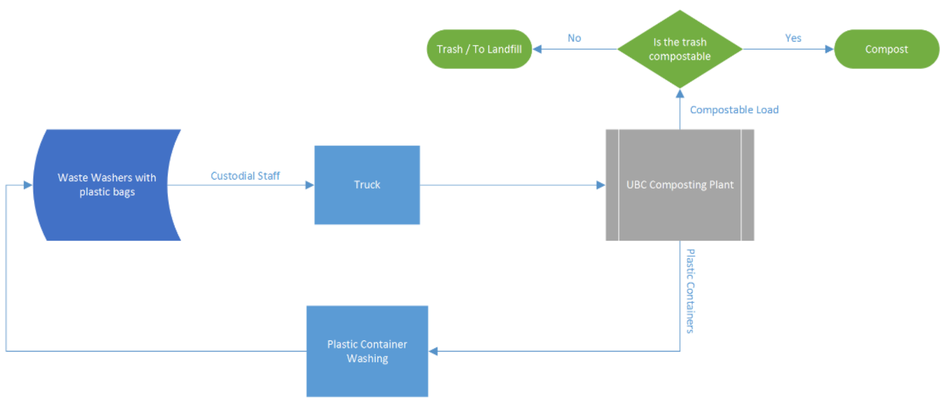

Figure 5: Bagless system process diagram

5.1 Solution Description

For this proposed solution, the Waste Watcher compost bins would remain unlined. During the standard hours, the custodial staff would remove these bins and replace them with a clean Waste Watcher bin. Therefore, this solution requires that there would be double the amount of bins needed in campus buildings to allow for full turnover for bin washing. The bins would be collected and placed in the truck for transporting to the UBC composting facility. To optimize space in the trucks and to avoid frequent trips between buildings and the compost facility, the bins with lesser amount of compost would be dumped into other bins such that there will be fully filled bins and empty bins that can be stacked in order to conserve truck space. These bins would then be taken to the composting facility where the compost would be transferred for further processing. The bins would be taken to the washing stations where they would be cleaned and then brought back into circulation.

5.2 Advantages and Disadvantages

The key advantage with this system is it eliminates the waste produced in the form of bin liners by the composting system. Moreover, this solution would be economically beneficial as this in turn would save costs on ongoing compost bag purchases. Furthermore, unlike other proposed solutions, this solution would not require the existing system to be drastically modified. This will save costs that perhaps would have been necessary for any system or equipment modifications.

5.3 Triple Bottom Line Analysis

The triple bottom line analysis for this solution will be approached differently as compared to the previous two solutions since there are more details to indicate in a longer format.

The cost analysis of this proposed solution, which ultimately defines the economic analysis, will examine the cost of water, productivity costs, and the cost of circulating extra bins. As stated previously UBC has about 450 Waste Watcher bins, and each can be estimated to use 8.82807 cubic feet to wash (0.25 cubic meters). Using the BC/Vancouver 2016 water pricing statics water costs about $3.23 from June to September and $2.584 for the rest of the year meaning that on average UBC spends $2.907 per year per 100 cubic feet of water. Therefore, we spend $0.28594109 per bin just in terms of the water cost for washing the bins. In terms of the cost of labour, assuming wages are $10.45 an hour and assuming it takes one minute to wash a single bin and replace it, the cost per bin is $0.17417 per labour hour. Finally, assuming we have to buy one whole new set of bins, then the cost is $15,750 as an upfront one time cost.

So in conclusion the capital cost of this solution is $15,750 with a water and labour cost of $0.460 per bin per day which translates to a water and labour cost of about $207 per day for all the bins. Therefore, it can be predicted that economically the bagless system is worthy solution for the SEEDs program to consider. However in accordance with a TBL analysis, we have to examine the environmental factors. Perhaps, the most obvious environmental indicator is the water being used since washing all of these containers takes about 250 ml for each container, which estimates to around 113 liters per 450 containers. However, after reading the article by the GRACE communication foundation (Grace, 2016), it takes about 90 liters to make 460 grams of plastic bags and each plastic bags weighs about 8-10 grams (Hellman, 2009). It can be seen that when it comes to water supply, the hidden cost of plastic makes it more water expensive. That said the bins will be made out of plastic however they are estimated to have a lifespan measuring many years. The bagless solution also removes the need to use the various chemicals used by the plastic industry, which is ultimately damaging to the environment, and reduces our reliance on oil for the raw materials for plastic. It should also be noted that the water in the bagless system can go towards water treatment similar way to the CIRS building's system so that it can be reclaimed, however the water that goes into a plastic bag cannot be reclaimed.

And finally, when dealing with social indicators for the bagless system, the main focus was on the custodian staff and compost facility workers since this change will have the largest impact on them. However consideration was taken into account for all other users as well.

One of the primary changes is the transportation schedule. Currently, each of the sustainability trucks carries 16 green Schaefer bins (two rows of eight). If the Waste Watcher bins were to be transported, we could potentially fit more on the back of the truck. Given the fact that waste watchers are almost half the size of the green bins in width and slightly smaller in length, we estimate a capacity of about four rows of eight bins. While this is an increase, it has to take into account the fact that the green bins are a combination of more than two full Waste Watcher bins combined. Therefore, the existing system does have the edge in transportation. As not all Waste Watcher bins are full, if the bins were to be transported on the back of the truck, this would require almost doubling the amount of trips back to the composting facility in order to move the same amount of material. Another approach to this problem is to dump all the Waste Watcher bins in each other and place the full ones in the truck, leaving one to two spots for stacked empty bins. This could greatly improve the efficiency of the system by allowing for a greater number of bins to be transported in a single trip. However, due to the size of the Waste Watcher bins, the truck would still overall hold less material, making this a downgrade from the existing solution. Furthermore, this may still cause some slowdown in the bin collection and transportation process compared to the current system.

Another important consideration is the effect of worker schedules and routines. This is important because the bagless solution would involve the custodial staff to change their schedule and use a roller so that they can move bins instead of bags of compost. This would also involve them potentially lifting the bins which can make it a very physically demanding task that should be noted and researched if this solution is considered for potential implementation.

Finally, another important community consideration is the fact that most Waste Watcher bins don't fill up in a day, and removing all of them once a day could be seen as inefficient. Hence, there is a possibility of emptying them once every two to three days, such solution would further save on water, fuel cost and worker time, but would make the aspect of smell an issue, since most compostable material will begin to release odours if left for more than 24 hours. However, given the fact that all of the Waste Watcher stations have lids/covers on them, this would mitigate the effect of odours caused by the compostable material. Moreover, a plastic or airtight material could be fitted on the lids to ensure that no smelly odours leave the bin when it is closed.

Given all of the above considerations, it can be seen that a bagless system is an appealing solution for the UBC composting system. It will allow for zero bag waste and, in comparison, a minimal amount of further waste in the form of fuel and water. This solution is the most cost effective and the least disruptive to the current system.

6.0 Conclusion and Recommendation

After analyzing the social, economic and environmental aspects of the three proposed solutions, the most viable solution that best meets the Triple Bottom Line key factors is the bagless bins. A bagless system can be integrated into the current composting system with minimal effort as drastic system or equipment changes are unnecessary; this saves a large amount of system integration time. Compared to the compostable paper bags that require expensive ongoing purchases, a key benefit of this implementation is that there are no large continual costs which is a large economic asset. Even though the transportation procedure for the bagless system may be longer and more complicated compared to the existing system, this may be a valid sacrifice to make for the overall benefit of implementing this system. A bagless implementation would surely facilitate in reducing plastic bag waste in the current composting system and from this analysis, it is the most feasible implementation from this investigation.

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