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Cost-benefit Analysis of Compostable Food Serviceware: A Case Study of an Educational Institute in California

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Authors' contributions

This work was carried out in collaboration between both authors. Author KK designed the study, prepared questionnaire for the survey, performed the statistical analysis and wrote the first draft of the manuscript. Author MA performed the survey, managed the analyses of the study and helped in writing the first draft. Authors KK and MA both managed the literature searches. Both authors read and approved the final manuscript.

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Case Study

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ABSTRACT

Globally, many educational institutes are focusing on implementing sustainability goals by encouraging the use of compostable products over the plastics, reducing waste, conserving water and others. The study performs a financial assessment of using Compostable food service ware (CSFW) in the Middlebury Institute of International Studies (MIIS), Monterey, California. To better understand the financial implications of the use of compostable food ware, comparisons have been made with the traditional reusable food service ware (RSFW). The results were calculated and compared through different approaches including data analysis, a Cost-Benefit Analysis and Net Present Values (NPVs). NPV values of compostable resulted in positive figures at different discount factors where a 3% discount rate has a higher value. The study concludes that investing in CSFW could be a financially sound approach as this practice is not only cost-effective but has certain environmental benefits over the reusables. The findings of our study can be used in the decision-making process by the educational institutes and other organizations while targeting their sustainability goals. Further studies can be done to evaluate the in depth analysis of assessing costs of production, carbon footprints and to determine the payback period of both types of items.

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1. INTRODUCTION

Educational Institutes have the potential to provide in-depth knowledge and leadership to approach various environmental challenges. Globally, several colleges and universities are implementing environmental programs to ensure sustainability. Some of the focus areas include energy & water conservation, promoting eco-friendly & renewable sources, reducing the use of plastics and waste management [1]. Reducing the use of plastics has become one of the important areas of interest, as over the years the use of single-use plastics has tremendously risen. For example, plastic cutlery such as forks, spoons, and knives have become the convenient choice for many commercial uses. The use of plastics has serious environmental concerns as these are non-degradable and a major contributor to street litter, ocean pollution, poses serious risks to marine and other wildlife. A 2014 study estimates indicate that there are more than 268,940 tons of plastic in the marine environment that accounts for approximately 5.25 trillion plastic particles floating in the oceans [2].Another study in 2017 explored the quantity if plastic that falls to the ocean floor and estimates that around 8.5 million metric tons settle on the ocean bottom annually [3].

As the awareness of the negative impacts of single-use plastic products is increasing, the use of compostable materials or bioplastics as food service ware is gaining momentum. These types of biodegradable materials are made from natural polymers that will decompose when introduced to the specific environment. ALCA (Life-cycle assessment) study which means identifying the processes and stages of products to understand its environmental effects of compostable report that remarkable environmental benefits can be obtained by shifting from the conventional plastic ware [4]. It is expected that bioplastic global production will increase by 18.8 percent from 2017-2022 [5,6]. Fig. 1 shows the forecasts of global production capacities of biodegradable bioplastics. There are a growing number of different brands that offer compostable service ware made from natural resources such as polylactic acid (PLA), potatoes, and wood chips [7,8]. Many commercial businesses, organizations, and institutes are promoting the use of compostable or reusable products to reduce dependency on plastics. Washington state in the United States of America (USA) is planning to promote compostable service ware among its offices and institutes that will be a step towards achieving its sustainability goals [9]. Recentlyin year 2018, the New York City (NYC) has joined an alliance of cities including Chicago, Miami and Los Angeles to use biodegradable service ware for about 1,250 NYC schools [10]. Besides, the Minnetonka Middle Schools in the USA transitioned into using reusable food service ware for school lunches and observed that 70% of the garbage generated in cafeterias was from plastic flatware, portion bowls, wrappers and bags [11].

Several studies compare Life Cycle Assessment (LCA) of the single-use compostable and

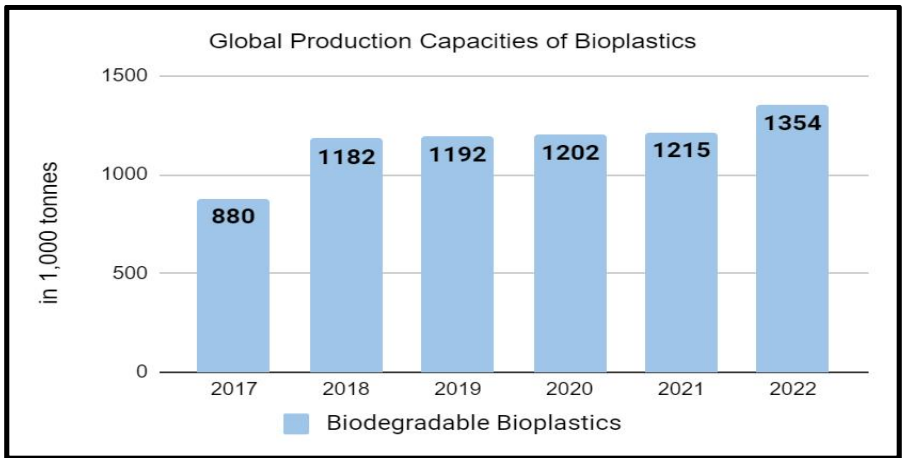

Fig. 1. Global production capacities of bioplastics from the year 2017-2022
Data Source: European Bioplastics, nova-Institute, 2017

recyclables [12,13,14] however, very limited studies have assessed the financial feasibility of the eco-friendly materials. It is important to understand the cost-benefits of these products while transitioning from traditional plastic materials to sustainable products which will help in right decision-making processes. Keeping this in view, this study focuses on assessing the financial feasibility of using CFSW by comparing with the Reusable Food Service Ware (RFSW) in one of an educational institute in California, the Middlebury Institute of International Studies (MIIS) located in Monterey.

2. MATERIALS AND METHODS

2.1 Study Location and Overview

The Middlebury Institute of International Studies (MIIS) located in Monterey, California, USA focuses efficiently on sustainability. The average student on campus is about 1700 per semester. The use of CFSW is among several approaches the Institute has adopted in order to meet its sustainability and carbon net neutrality goals. The idea of including compostablefood ware replacing the plastic materials was adopted in 2017 which is owned by a private vendor named Aqua Terra. After the effective implementation of policy, the plastic cutlery items including drinking cups, utensils, napkins, and food containers in the cafeteria were replaced by the BPI (Biodegradable Products Institute) certified CFSW that offers a more environmentally friendly alternative to plastic service ware. In addition, the Institute added three 64-gallon composting bins to their cafeteria area and these bins are picked up weekly that costs around $31.70 to operate per bin per month. The waste collected from the composting bins is further sent to the anaerobic digester facility which is under the jurisdiction of Monterey City Disposal and also meets the requirements for proper decomposition of biodegradable products.

2.2 Study Plan and Data Collection

The study was designed after the literature review of case-studies and sustainability reports. Based on the review, an interview questionnaire was prepared to obtain detailed information on the current practices of using compostable including quantity of CFSW used daily; amount of compostable waste generated; current waste disposal practices; costs of compostable items; operating costs for purchasing items; and others. The information was collected by the authors through email and personal conversations with the facility managers, cafeteria workers, students and sustainability manager of MIIS. For data related to Reusable Food Service Ware (RFSW), baseline information was collected from the report 'The Cost and Environmental Benefits of Using Reusable Food Ware in Schools: A Minekotta case study' [15].

2.3 Data Evaluation

The data was collected for the usage of CFSW in Aqua Terra at MIIS. Some assumptions and calculations were made to estimate the costs of transportation, waste disposal based on the inflation rates. Similarly, a reference to the Minekotta Schools case study [15] provides a baseline for making assumptions for the RFSW and the values for capital expenses were adjusted accordingly. Few assumptions related to the operating costs of RFSW were made that includes calculating and estimating the labor, electricity, water use costs based on the state of California rates. The final model calculated and compared the annual costs of usage of compostables and reusables, and their operating costs based on inflation rates for 20 years. A Cost-Benefit Analysis was done to determine the Net Present Values (NPVs) of both the products at discount rates of 3%, 5%, and 7%. Based on the results, a final financial evaluation of using one type of product over the other was made.

3. RESULTS AND DISCUSSION

After the implementation of Compostable food ware policy, MIIS started using compostable products made up PLA. PLA is made from corn starch that breaks down in a controlled composting environment that requires around 140 degrees Fahrenheit and digestive microbes [16]. It was observed that on an average around 150 meals are served per day during the business operations that account for roughly 300 compostable items including plates, cutlery, cups and bowls usage per day. Table 1 gives an overview of the operation of Aquaterra Cafeteria in MIIS.

The findings of the survey provide details on item-wise costs of different compostable, and reusable product items, as shown in Table 2. Based on the tem-wise costs, annual estimates were made for CFSW and RFSW.

The comparative costs analysis of compostable and reusables was done based on the annual upfront and operational costs (OPEX). The

Table 1. Overview of aqua terra cafeteria at MIIS

Parameters	Description
Name of business	Aqua Terra
Number of meals per day	150
Operation Period	During sessions (January - May and August - December)
CFSW Product type	Brand name: Stalk Market Brand, Product: PLA
Certification	BPI certified

Table 2. Comparative costs of different product items

Item	Cost/item (compostable)	Cost/item (reusables)
Large flat Plates	$0.13	$8.49*
Box	$0.27	-
Oval plates	$0.27	-
Cups with lids	$0.15	-
Cost of cutlery (forks/knives/spoons)	$0.05	$3.37

**Three compartment stainless steel plate*

annual upfront costs of CFSW includes the cost of purchasing the items while the OPEX includes the transportation costs for purchasing the items and the waste disposal costs. The RFSW requires one-time upfront costs for the purchase of items while the OPEX of reusables involves labor costs, dishwasher installation, transportation, damage costs, water and electricity costs (also includes waste avoided costs). The results indicate that during Year 1, the upfront costs for CFSW accounts for $6,723 whereas the annual costs for reusables accounts for $3,915. However, the OPEX of compostable is way lower (around $219 annually) than the reusables (around $ 6,263 annually) as it involves only waste collection and transportation costs while for reusables the cost of utilities to clean the reusables every day and labor costs leads to high OPEX. Fig. 2 shows the first-year annual cost of both types of items indicating compostable to be more financially feasible.

Assuming that the same RFSW is used for two-four years with 10% of damage costs annually, the cost of reusables comes out to be lower as compared to the compostable. However, the analysis for a period of 20 years shows varied costs for RFSW and CFSW as can be seen in Fig. 3. This is because, over the 20-year period analysis, it was assumed that the old RFSW is replaced with new items after every five years and factor of inflation is also considered for utilities and waste transportation. The utility costs were adjusted for 20 years based on the current inflation rates of Monterey County and the California State where inflation rate of 5% was considered for waste transportation, electricity and water was considered.

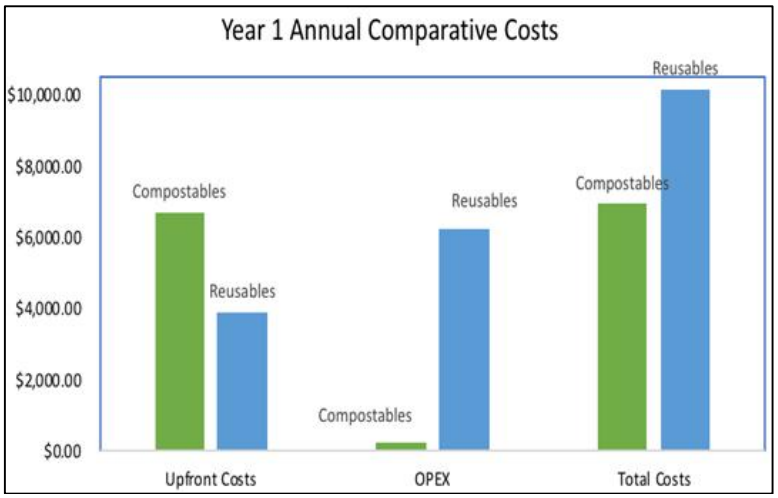

Fig. 2. Year 1 annual comparative costs of compostable and reusables

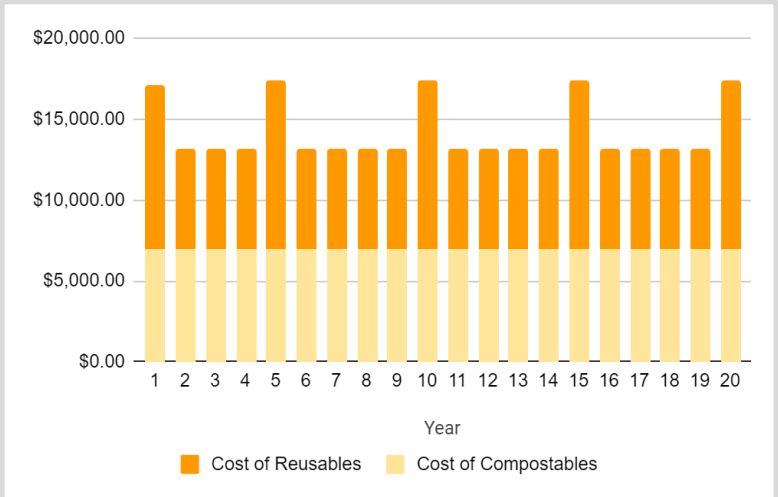

Fig. 3. Comparative costs of compostable and reusables over a period of 20 years

To further our study, a Cost-Benefit analysis (CBA) was done to evaluate the NPVs of both types of products at discount rates of 3%, 5%, and 7% for 20 years. The CBA outcomes show that compostable products are more financially feasible over the reusables. The NPV results of compostable were positive and indicate that a discount rate of 3% is more favorable as indicated in Table 3. Also, the environmental benefits of using CFSW are high as it does not involve any costs in terms of water and energy use. The findings of the study are somewhat in line with the study [17] which reports that reusable cups are impractical for large scale uses or events in Barcelona, Spain, in addition to having high greenhouse gas footprints.

Table 3. NPVs of compostables at different discount rates (NPV in $)

Discount rate	3%	5%	7%
NPV	5180.8	4499.1	3999.0

The cost-benefit analysis indicates that the use of compostable is financially feasible as compared to the reusable products. The current practice of using compostable food service ware is the right approach taken by the Institute to achieve its sustainability goals while considering the cost factors too. However, this study has not taken in account all the environmental factors due to lack of concrete data to quantify overall costs of both types of products. There are few studies that evaluate only the environmental benefits of one type of product over the other. For example, a study examined food service ware in cafeterias at the University of Colorado at Boulder and observed that reusable polycarbonate salad bowls had lower global warming potential impacts than single-use compostable bowls after less than 10 uses [13]. Various other studies examined energy or environmental impacts of foodservice ware, however they either lacked quantification, cost analysis or comparisons with other reusable service ware [18,19]. Furthermore, there are no reported studies that directly perform cost-benefit analysis of compostable foodservice ware and compared it with reusable products. But, one study quantified the potential effects of restrictions on expanded polystyrene food service products in Maryland. This study reports that for every $1 spent on polystyrene food service products, the replacement alternatives such as compostable products will have higher price and would cost an average of $1.85. The desirability of using compostable products in the food joints including school cafeterias relies on number of factors such as availability of product, type, price, cross contamination of discarded products, availability of suitable disposal and compostable alternatives. Therefore, it is suggested that the educational institutes should consider all the factors including the costs and environmental while making decision to achieve their targeted sustainability goals.

4. CONCLUSION

This study focuses on evaluating the financial feasibility of using compostable foodservice ware and observe that while the annual cost of using compostable after year 1 is high in comparison to the reusables, the net present value (NPV)

remains high for the compostable at 3% discount rate. The findings of our study indicate low operational costs for compostable indicating short-term investments for compostable are low when compared to reusables. The study provides a good overview to identify financial assessment of one type of product over the others, as both have certain environmental benefits over the use of plastic items. The findings of our study can be used in the decision-making process by the Institutes while targeting their sustainability goals. Further studies could be done to evaluate all the environmental factors and get deep insight of costs of production, payback period, C footprints, and other environmental factors to assess the sustainability of both types of items.

5. RECOMMENDATIONS

Based on the findings of the study following recommendations are suggested:

5.1 Decision Making for Compostable Use

While the outcomes of the study indicate compostable as a more financially feasible option, they do present a problem at the end of their life cycles, if not disposed of properly. Aside from the inventory costs to consistently maintain a steady supply of single-use compostable products available for consumers, the end of its life cycle adds a level of complexity, both financially and logistically, when any organization takes on the responsibility to adapt compostable food service ware policies. Therefore, an organization, conscious of its spending must take into account these types of events to evaluate whether or not it is financially feasible.

5.2 Finance Responsibility

Currently, MIIS has contracted its cafeteria to AquaTerra and a part of the contract delegates that the costs associated with purchasing and replacing the compostable service ware are to be absorbed by the catering company (except for the compostable waste collection). During our findings, it was discovered that if MIIS chose to replace the current policy with the reusable service ware, then all of the capital expenses and operating costs incurred from the replacement process would be outside of Aqua Terra's contract and at the financial discretion of MIIS. This is an important factor to consider when renegotiating the contract with Aqua Terra and justifying the calculations of the company's terms of use with the maintenance of the reusable trays and cutlery.

5.3 Internal Rate of Return (IRR)

MIIS's endowment fund is dispersed to campus projects that payback within two years. When calculating the IRR to determine the payback period for the reusables project and make a comparison, the result was inconclusive due to the negative cash flows for the twenty years. Therefore, no recommendations were made to determine MIIS's financial favorability for a project that would replace the current compostable service ware policy.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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