DISSERTATION

LIFECYCLE ASSESSMENT MODELING AND ENCOURAGING REUSE IN THE CORRUGATED PACKAGING INDUSTRY USING PERSUASION AND OPERANT CONDITIONING

Submitted by

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ABSTRACT

LIFECYCLE ASSESSMENT MODELING AND ENCOURAGING REUSE IN THE CORRUGATED PACKAGING INDUSTRY USING PERSUASION AND OPERANT CONDITIONING

Greenhouse gas emission is a major contributor to climate change and global warming. Many sustainability efforts are aimed at reducing greenhouse gas emissions. These include recycling and the use of renewable energy. In the case of recycling, the general population is typically required to at least temporarily store, and possibly haul, the materials rather than simply throwing them away. This effort from the general population is a key aspect of recycling, and in order for recycling to work, some investment of time and effort is required by the public. In the case of corrugated cardboard boxes, it has been observed that there is less motivation for the general population to recycle them. Also, the manufacturing of a product such as a corrugated cardboard box (CCB) includes the extraction of a variety of raw materials in addition to supply chain efforts to get the raw materials to the industry. The extraction of raw material and its supply chain as well as the unproper end of lifecycle phase can significantly impact the carbon emission of a product over its lifecycle. This research explores different means of motivating people to reuse, and not just recycle, with different types of incentives. It addresses the use of persuasion techniques and operant conditioning techniques together to incentivize the general population to adopt sustainable efforts. Further, this study makes an attempt to segment the general population based on age, gender, persuasion preferences, operant condition preferences, personality types, awareness of environment/climate change as well as current recycling effort of the participants to use different forms of incentives and motivational work unlike any approaches found in the literature review. Four types of persuasion techniques and four types of operant conditioning are combined to give 16 different types of incentives. Three online surveys are conducted, and their data are analyzed (using entropy, Hamming

distance, t-test, chi-square, and ANOVA). The results indicate that “positive reinforcement + ethos” is a cost-effective way to incentivize the general population. This study also conducts a Lifecycle Assessment (LCA) that gives the carbon emission of each phase of the product and a quantitative estimate of the overall product carbon footprint and its effect on the environment. This gives impetus to recommendations for improving the phases of the lifecycle to minimize carbon emissions. This research uses LCA to evaluate the carbon emission in each phase of the lifecycle of a typical 1 kg corrugated cardboard box in the United States. Carbon emission for the proposed “reuse” phase is also calculated, and the results are compared. To examine if the incremental cost of reusing the CCBs is less than the environmental and economic cost of reducing the extraction and supply chain of raw materials, this study explores the economic feasibility of the proposed “reuse” method that incentivizes the general population to reuse the CCBs instead of recycling or landfilling them. Economic tools such as willingness-to-pay vs. marginal cost curves and benefit-cost analyses are used to evaluate economic feasibility. The results indicate that the “reuse” method for CCBs is economically and environmentally feasible. It also supports the approach of using analytics, economics, and LCA to create a model that can be used for other products and processes as an evaluative process to determine if businesses can benefit from the reduction (or removal) of material extraction costs from the supply chain. The results of this study can be applied to a wide range of applications such as solar panels, incentives for vaccination, and other areas wherein sustainability-centric behavior is encouraged.

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DEDICATION

To

Padmaja Ketkale, Digvijay Ketkale, and Jyoti Patil

And in Loving memories of

Chandrakant (Raju) Adinath Ketkale

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1 GENERAL INTRODUCTION

The rise in e-commerce has increased the use of corrugated cardboard boxes (CCB) [1]. CCBs are widely used for the shipping and transportation of goods. Corrugated cardboard boxes are made up of corrugated board which is made from corrugated sheets. As it is an important part of the supply chain for a large number of goods, it is worth exploring its manufacturing process and addressing its underlying problem from a holistic view. The manufacturing of CCB starts with harvesting softwood and hardwood. This harvesting process consists of cutting, de-limbing, loading, and transportation of the logs. These logs then go through the process of de-barking and chipping to produce wood chips. Companies also purchase wood chips from sawmills and chip mills. The wood chips are then converted into pulp (virgin wood pulp) and then mixed with pulp from recovered fiber (pulp from the recovered fiber is generated from recycling old corrugated cardboard boxes). Wood chips are then cooked at high temperatures and pressure with recycled pulp and other chemicals at specific parameters to get desired properties in the pulp. This pulp is then separated, screened, and washed before sending it into the paper-making machine. The paper-making process is shown in Figure 1.1.

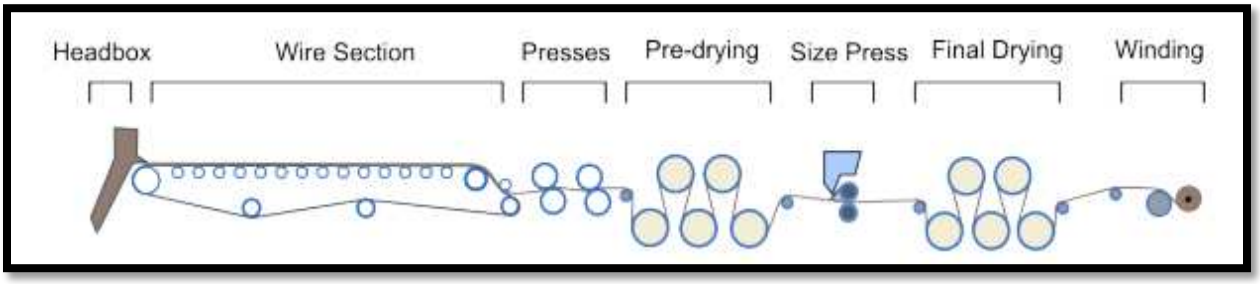


Figure 1.1 Paper-making process [2]

The pulp enters from headbox where a homogenous sheet with specific width is made and fed into the wire section. In the wire section the water is drained from the slurry and fibers are then fed into the presses. The fibers then go through a series of presses and drying stages with additions of starch and other

chemicals as needed. After drying the containerboard is then cut into the required size and rolled for transportation.

The containerboard is then transported to converting plants, where it is converted into a corrugated cardboard box. Figure 1.2 shows the process of converting the containerboard to corrugated board.

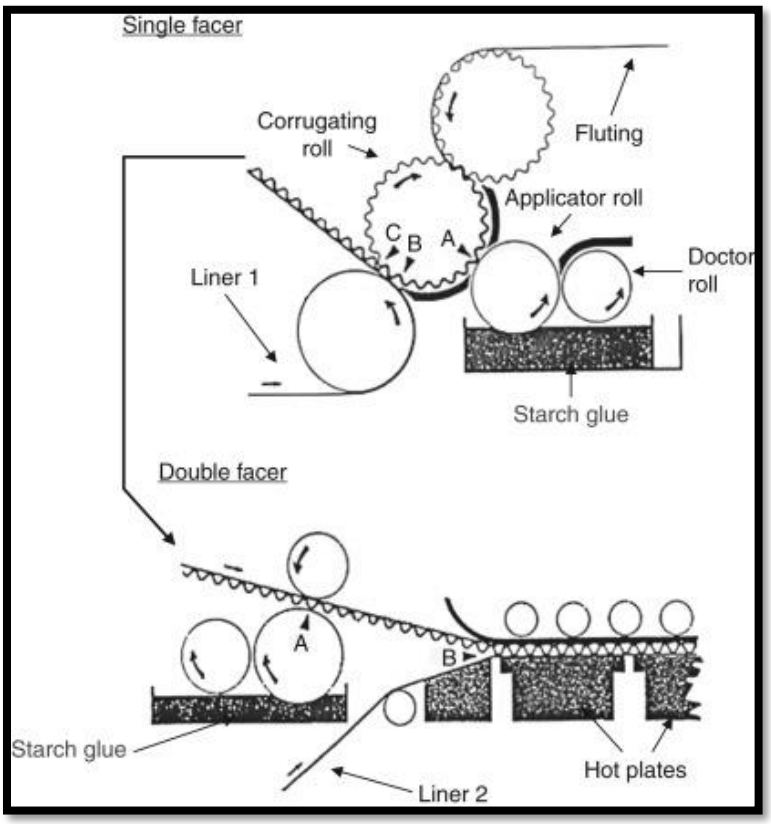


Figure 1.2 Converting process [3]

There are two types of containerboards: liner board and corrugating medium. The corrugating medium containerboard is fluted between the two liner boards to create a single-layered corrugated board. As shown in Figure 1.2, the corrugated medium is fluted, and starch glue is applied to the tips of the flute. This fluted tip with starch glue is then glued to the inner surface of the linerboard. The starch glue is then applied to the other side of the fluted tips and glued with the inner surface of another linerboard. Thus, a

single-wall corrugated board is manufactured. This corrugated board is then dried and slit into the required shapes. The final stage of this process is folding, gluing, and printing the corrugated boards in the required box shapes. These final products are then stacked are packed for shipping. It is important to note that the corrugated boards have different board styles (single wall/double wall/ triple wall) and flute types (F flute/E flute/C flute/B flute/A flute). The corrugated cardboard boxes also differ in shape and size with respect to their end application.

Each year approximately 100 billion CCBs are manufactured in the United States. Approximately, 70-75% of 100 billion boxes are received for recycling each year [4,5]. In 2018 out of the total CCBs received (33.3 million tons) for recycling, 2.82% (0.94 million tons) were mixed with landfilled, 0.69% (0.23 million tons) was combusted and 96.5% (32.1 million tons) was recycled [6]. Although a recycling rate of 96.5 % is impressive, it applies to the number of CCBs received for recycling. The CCBs that are not received for recycling end up in a landfill. In order to recycle a CCB, an individual has to take them to a recycling center or place them in a recycling bin, if/where available. It has been observed that 90% to 100 % of the boxes received by big-box stores and grocery stores are sent back for recycling. Betsy Dorn, director of RSE USA stated in an article by USA Today [7] that "nationally, consumers send back 25% of their CCBs". This shows that the general population is not motivated enough to recycle. There are many reasons why individuals are not inclined to recycle CCBs. One of the reasons is that in order to fit big CCBs in recycling bins, individuals have to fold them and/or cut them. On the other hand, according to Recycling Partnership's "State of Curbside Recycling" report [8], curbside recycling services are only available to 60% of US homes. That means 40% of US homes do not sign up / do not have access to curbside recycling services. Apart from the lack of motivation in the general population to recycle the CCBs, a typical CCB is made up of 50% virgin fibers and 50% recycled fibers [9,10]. This means the need to cut down trees to manufacture CCBs will still be in place even if all the CCBs are recycled. Thus, recycling CCBs is not an absolute solution and needs further improvement. Also, a huge amount of carbon is emitted during the

extraction process of virgin fiber from trees and recycled fibers from the recycling phase [11]. Thus, in order to address the shortcoming of the current state of the lifecycle of CCB, it is important to develop a new process and additional research in testing the feasibility of that proposed process. This research proposes a new process of "reusing" the CCB multiple times before recycling it. This reuse process includes incentivizing the general population to allocate the CCBs they received to a "reuse" container. A truck would collect these CCBs and transport them to a location where CCBs are checked for damages and resold to the general population. The CCBs that are damaged or are not in a condition to be reused shall be then assigned for recycling. This research goes on to evaluate the different motivational approaches as well as collection methods and calculates carbon emission from the reuse phase. Further, the research goes to evaluate the economic feasibility of the solution.

2 AIMS AND OBJECTIVES

The objective of this study is to propose a new process that increases sustainability efforts and addresses the underlying problem regarding the current lifecycle of CCBs. To achieve this goal, the study endeavors to answer the following research questions:

1. How to incentivize the general population to motivate them towards making a sustainable effort like reusing the CCBs instead of recycling or landfilling them?
2. Which type of incentives would be most effective with respect to the cost of motivation? And how much would it cost?
3. To evaluate if segmenting the general population would be more beneficial to efficiently motivate them to make sustainable efforts like reusing CCB?
4. How much carbon emission is saved by reusing the CCBs instead of recycling or landfilling them?
5. Is the reusing process economically feasible?

3 ENCOURAGING REUSE IN THE CORRUGATED PACKAGING INDUSTRY USING PERSUASION AND OPERANT CONDITIONING

3.1 Introduction

Pollution is a major current global problem, as it leads to global warming and associated climate change due to the depletion of the ozone layer, increase in global temperature, rise in sea level, melting of glaciers, and other adverse events. According to the United States Environmental Protection Agency (EPA), pollution is defined as "Any substances in water, soil, or air that degrade the natural quality of the environment, offend the senses of sight, taste, or smell, or cause a health hazard. The usefulness of the natural resource is usually impaired by the presence of pollutants and contaminants" [12].

To reduce global warming and climate change, humans can turn to the use of renewable fuels, use sustainable transportation, reduce waste, promote recycling, and other measures. One of the key aspects of all these solutions is to reduce the emission of greenhouse gases (GHGs). According to the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report, "Recycling reduces GHG emissions through lower energy demand for production (avoided fossil fuel) and by substitution of recycled feedstocks for virgin materials" [13] (p. 602). In short, recycling leads to indirect energy-saving and an avoidance of/reduction in GHG emissions. The recycling process in the United States started as early as 1960 with the manufacturing of paper with recycled fibers from cotton and linen rags. Since then, the recycling industry has evolved and is applied worldwide for many different products and materials in addition to paper. The United States passed the Solid Waste Disposal Act in 1965 and the Resource Conservation and Recovery Act in 1976, both aimed at reducing waste and decreasing pollution. Although the recycling process is currently well established, the recycling rate in

the United States in 2019 was only 32% [14]. The US Environmental Protection Agency (EPA) calculates recycling rates as the percentage of total municipal solid waste (MSW) recycled. The "recycling rate" metric can be confusing, as it accounts for the total waste received with respect to the percentage of waste that was recycled. Recent studies in the field of sustainability efforts have tried to identify the problems and barriers experienced in the recycling process in different fields and different parts of the world [15–19]. Another example of poor recycling efforts can be seen in the fact that 91.3% of all the plastic waste that is generated in the US was not recycled in the year 2018 [14]. Overall, limited improvement is observed in the US with respect to recycling rates [18].

A particular product of interest in the recycling/reuse arena is the "Corrugated Cardboard Box" (CCB). The CCB is widely used in the packaging industry and is made from wood. Approximately 100 billion boxes are manufactured in the US each year. Out of the 100 billion boxes, approximately 70–75% of these boxes are received for recycling each year [4,5]. The remaining 25–30% of the boxes are not received for recycling, and thus cannot be recycled. In 2018, 96.5% of corrugated cardboard boxes that were actually received for recycling were recycled, whereas 2.82% of these boxes were mixed with landfills and 0.69% of these boxes were combusted [6]. In 2018, corrugated boxes were the largest single product category received as municipal solid waste in the US. Approximately 33.3 million tons of CCBs were received, out of which 0.94 million tons were mixed with landfills, 0.23 million tons were combusted, and 32.1 million tons were recycled.

Even if the above numbers are impressive, there are certain underlying problems with the recycling process of CCBs. According to the Corrugated Packaging Alliance [9] and the Fiber Box Association [10], a typical corrugated cardboard box is made up of 50% of recycled fiber. This also implies that, on average, every CCB contains 50% recycled fibers and 50% virgin fibers that are produced from trees. Thus, even if humankind manages to recycle all the CCBs ever produced, there will still be a need to cut down trees for virgin fibers to manufacture new CCBs. As [20] states "the

process of manufacturing of raw materials also causes pollution". Even though recycling helps in reducing the overall carbon emissions of a CCB over its lifecycle, it is not an absolute solution to the main problem. There is a need to further improve this process to reduce carbon emissions. Another problem with recycling CCBs is that the number of boxes received for recycling is low. Recycling a CCB can be achieved by taking the box to a recycling center or by placing the box in a recycling bin, if/where available. It has been observed that grocery stores and big-box stores recycled 90% to 100% of their CCBs. In an article by USA Today [7] Betsy Dorn, director of RSE USA, states that nationally, consumers send back 25% of their CCBs. The reasons that the general population is not inclined to recycle the CCB vary. One of the major reasons is that consumers need to cut down the boxes in order to fit in the recycle bin and to be accepted by recycling service providers. The article further states that the general population is not particularly motivated to participate in that kind of extra work. According to the Recycling Partnership's "State of Curbside Recycling" Report [8], only 60% of US homes have curbside recycling services. Thus, about 40% of US homes either do not have access to, or do not sign up for, curbside recycling. These are the main reasons for not receiving many of the CCBs for recycling with respect to the number manufactured each year.

In order to increase sustainable efforts, a new process needs to be established that tries to reuse the CCB multiple times before recycling it, and we also need to find a way to incentivize and motivate the general population towards accompanying sustainable efforts. The term "reuse" can be confusing as it is interpreted in different ways. The authors define "reusing the corrugated box" as using the corrugated box multiple times for packaging needs before discarding/recycling it. Although the "reuse" process has existed for decades, implementation of the reuse process of corrugated boxes by the general population using incentive strategies tied to personality was not found in the literature review. In this chapter, the authors investigate different means to incentivize the general population towards sustainable efforts at a low cost. The hypothesis this chapter evaluates is that segmenting

the general population based on different personality types and motivational attributes, such as persuasion and operant condition types, will be beneficial for motivating them to reuse corrugated packaging.

3.2 Materials and Method

There are many ways to motivate an individual. Guay et al. [21] refer to motivation as the reason underlying behavior. Gredler [22] defines motivation as "the attribute that moves us to do or not do something". As discussed before, there is a need to motivate the general population to reuse CCB. To motivate the general population, there needs to be a way to incentivize individuals, which is, in effect, the attribute/reason to be motivated. Incentives can be broadly categorized into two categories: financial incentives and non-financial incentives. In order to incentivize the general population, this research divides the incentive procedure into two parts. The first part of an incentive procedure can be stated as the grabbing of attention of the target population (persuasion). The second part of the incentive procedure can be stated as modifying behavior to repeat the required task (operant conditioning).

Grabbing the attention of the target population is addressed through persuasion techniques. Perloff [23] states that persuasion involves communication that is focused on altering behavior and attitude. O'Keefe [24] states that persuasion is non-coercive and intentional communication that effectively changes the behavior with a change in mental state. There are four types of persuasion techniques that are used in this research: ethos, pathos, logos, and aesthetics. These four types of persuasion techniques are defined below.

- Ethos—A persuasive technique that appeals via aspects of ethics, morals, conscience, values, standards, and principles.

- Pathos—A persuasive technique that appeals via emotions. These include aspects of memory, nostalgia, and shared experience.
- Logos—A persuasive technique that appeals via logic and reasoning. They usually include statistics, facts, and data.
- Aesthetics—A persuasive technique that appeals to beauty and people's appreciation of things.

In order to potentially influence the behavior of the target population to repeat the required task, this research explores the method of operant conditioning. B.F. Skinner [25] first introduced the concept of operant conditioning and defined it as "controlled by its consequences" [26]. There are four types of operant conditioning techniques that are used in this research: positive reinforcement, negative reinforcement, positive punishment, and negative punishment. These four types of operant conditioning techniques are defined below.

- Positive Reinforcement—Positive reinforcement is adding a pleasant consequence that leads to repeating the behavior.
- Negative Reinforcement—Negative reinforcement is taking away unpleasant consequences, which leads to repeating the behavior.
- Positive Punishment—Positive punishment is adding an unpleasant consequence that leads to avoiding the repetition of the behavior.
- Negative Punishment—Negative punishment is taking away a pleasant consequence, which leads to avoiding the repetition of the behavior.

With both sets of four related incentives defined and explained, it is worth restating that in this research, the incentives comprise two parts: operant conditioning and persuasion. Thus, Table 3.1 below gives the 16 types of incentive that are explored in this research.

Table 3.1 List of 16 types of incentives.

Positive Reinforcement Logos	Negative Reinforcement Logos	Positive Punishment Logos	Negative Punishment Logos
Positive Reinforcement Ethos	Negative Reinforcement Ethos	Positive Punishment Ethos	Negative Punishment Ethos
Positive Reinforcement Pathos	Negative Reinforcement Pathos	Positive Punishment Pathos	Negative Punishment Pathos
Positive Reinforcement Aesthetics	Negative Reinforcement Aesthetics	Positive Punishment Aesthetics	Negative Punishment Aesthetics

These 16 types of incentive are created by combining the four operant conditioning techniques and four persuasion techniques. It is argued that these 16 types of incentive should be tested for relative suitability for incenting sustainable efforts. In order to test these incentive methods, two surveys were conducted.

The authors also explored metrics that could influence or relate to the proposed 16 types of incentive. There are many examples of previous research where researchers have tried to pair the Myers–Briggs Type Indicator (MBTI) with different behavioral traits [27–30]. MBTI is widely accepted in the industry and many other organizations [30]. MBTI is often used for hiring and managerial training in order to study the behavior of the candidate and account it for the required job responsibilities. MBTI consists of 16 types of personality. This chapter investigates whether there is any influential relationship between the 16 types of personality with respect to the proposed 16 types of incentive. The 16 types of personality are based on 4 main factors with a continuum of personality scores or affinities, which are further simplified into two categories each: Energy (Introversion(I) or Extroversion(E)), Information (Intuition(N) or Sensing(S)), Decisions (Thinking(T) or Feeling(F)), and Organization (Judging(J) or Perceiving(P)). The combination of these 4 factors gives 16 different types

of personalities. Data are collected by conducting surveys, and various analyses are performed to elicit the results from the data.

The methodology used in this chapter is to test the hypothesis of segmenting the general population with respect to persuasion preference, operant condition preference, and personality type. This segmentation is hypothesized to be effective for motivating the general population to reuse the CCB.

3.2.1 Survey #1

There were 62 questions in total on this survey. The objective of this survey was to identify the operant conditioning and persuasion preference of each participant. This survey estimates each participants' personality typing with 12 questions instead of the traditional 93 questions. This survey also tries to understand the participants' perspectives on the 16 types of incentive that are proposed in this research. Below are the types of questions that were included in this survey:

1. Questions to assess personality type (12 questions)
    a. True or False questions (8 questions)
    b. Multiple-choice questions (4 questions)
2. Questions to assess persuasion preference (25 questions)
    a. c. Likert-type questions (20 questions)
    b. d. Multiple-choice questions (5 questions)
3. Questions to assess operant conditioning preference (25 Questions)
    a. e. Likert-type questions (20 questions)
    b. f. Multiple-choice questions (5 questions)

Survey #1 identified and assigned the operant conditioning preference, persuasion preference, and personality type of the participant. Survey #1 includes Likert scale questions to examine the need and

possibility to customize the incentive methods for a specific population group. These different types of questions help to evaluate whether there is a need to customize the incentive type with respect to individual preference (customized incentivization) over a single method of incentivization (universal incentivization). The main output from this survey was to understand the preference of the target population regarding the 16 types of incentive. It was also important to find how much each incentive method would cost, and to estimate the cost required to move a participant from their preferred incentive type to a new one.

Therefore, to address these new questions regarding the financial aspect of the incentives, the authors conducted a second survey (survey #2).

3.2.2 Survey #2

There were 25 questions in total in this survey. The objective of this survey was to analyze the financial aspects of each of the 16 incentives. The questions were also worded to identify how much it would cost to move someone from their preferred operant conditioning type to a new one by using their preferred persuasion type. This survey also tried to understand participants' perspectives on these incentives by asking them qualitative questions. Below are the types of questions that were included in this survey.

1. One multiple-choice question to assess how much it would take for participants to be motivated in their own preferred type of incentive.
2. Twelve multiple-choice questions to assess how much of an incentive would be required for them to choose from one operant conditioning type over another associated with their preferred persuasion type (12 questions for 12 transitions between four operant conditioning types).
3. Twelve qualitative questions about their views on every single transition between the four operant conditioning types.

Survey #2 identifies how much would it cost to motivate a particular individual to make a preferred effort at reuse. Additionally, it identifies and quantifies how much would it cost to change their operant conditioning and still motivate them to carry out sustainable efforts.

3.3 Results

3.3.1 Survey #1 Results

Survey #1 was published online on the "LinkedIn" social media platform, as well as being sent to the email lists of the students, faculty, and staff of Colorado State University. The Qualtrics tool was used to create the survey and collect the responses online. Survey #1 was active for 26 days and received 156 responses. The metadata from Qualtrics show that survey #1 received responses from participants in four countries. The median time to complete Survey #1 was 18.15 min.

Operant conditioning preferences and persuasion preferences were elicited based on the participant's response to multiple-choice questions that compared the four options to each other, respectively. The personality types of the participants were based on 12 questions, out of which 4 questions were taken from an article published on the internet [31], and the remaining 8 questions were created by authors in true/false format. For each of the four categories of personality type, the "best of three" rule was used to classify participants' preferences. Figures 3.1–3.3 show the data that were collected from survey #1 for 156 participants.

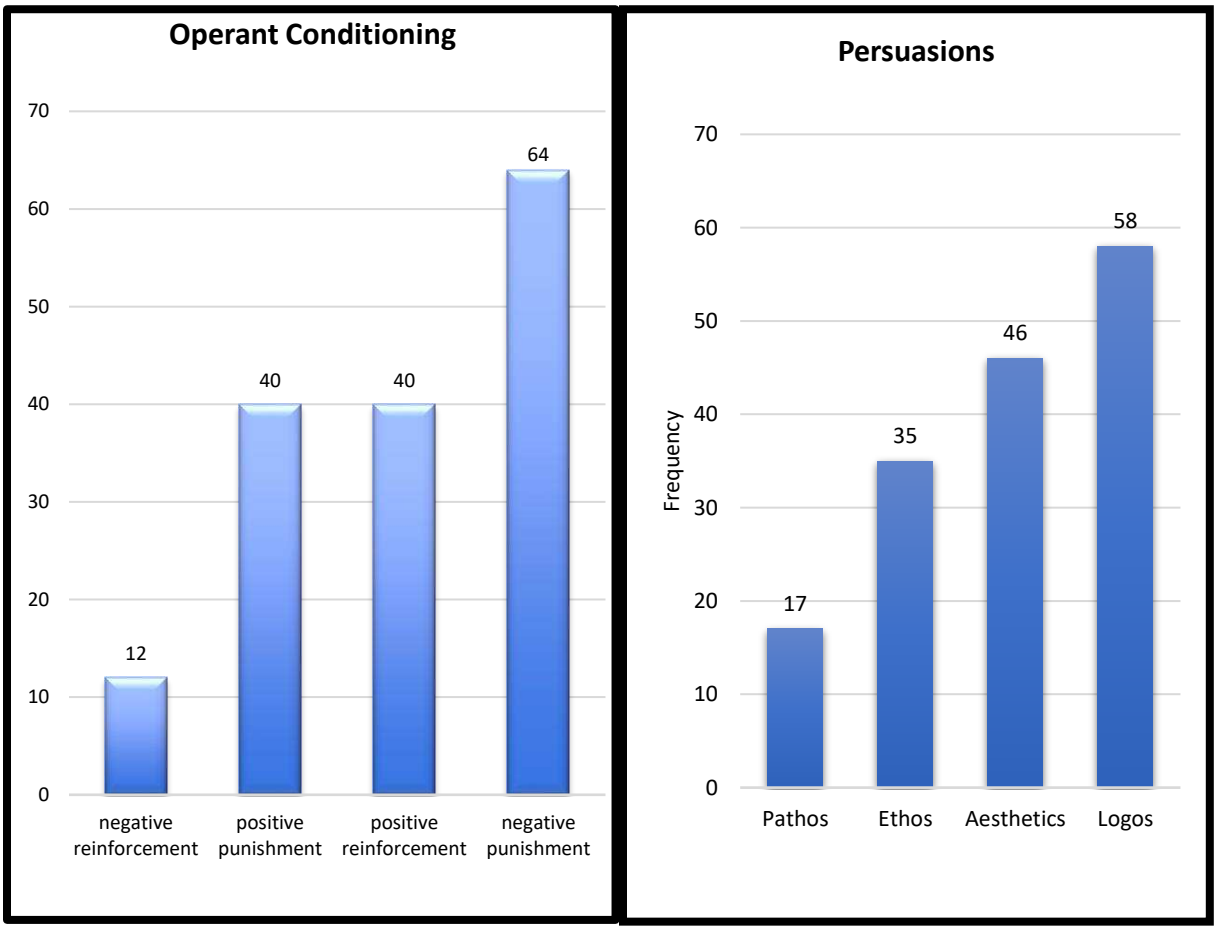
3.3.2 Analysis of Survey #1

There were five types of analysis performed on the survey #1 data, as detailed in 3.3.2.1 to 3.3.2.5.

3.3.2.1 Comparing Multiple-Choice Questions to Likert Scale Questions

The primary goal behind this survey was to identify participants' preferences for operant conditioning, persuasion, and personality type. As stated previously, it is also important to identify whether there is a need for customization with respect to the individual participant or group of

participants. In order to identify if there is a need for customization, this chapter compares the Likert scale question to multiple-choice questions with respect to their output on participants' operant condition preferences and persuasion preferences. The hypothesis used here is that when the results of operant conditioning and persuasion are compared for both multiple-choice questions and Likert scale questions, if the percentage of results from both question sets is more than the expected values (25% on random guessing), then the customization approach may be valuable and shall be considered. On the other hand, if the percentage of results from both question sets is less than or equal to the "randomly" expected value (25%), then the customization approach is deemed less valuable.



(a) (b)

Figure 3.1 Survey results for (a) number of participants belonging to each of the four operant conditioning preferences; (b) number of participants belonging to each of the four persuasion preferences.

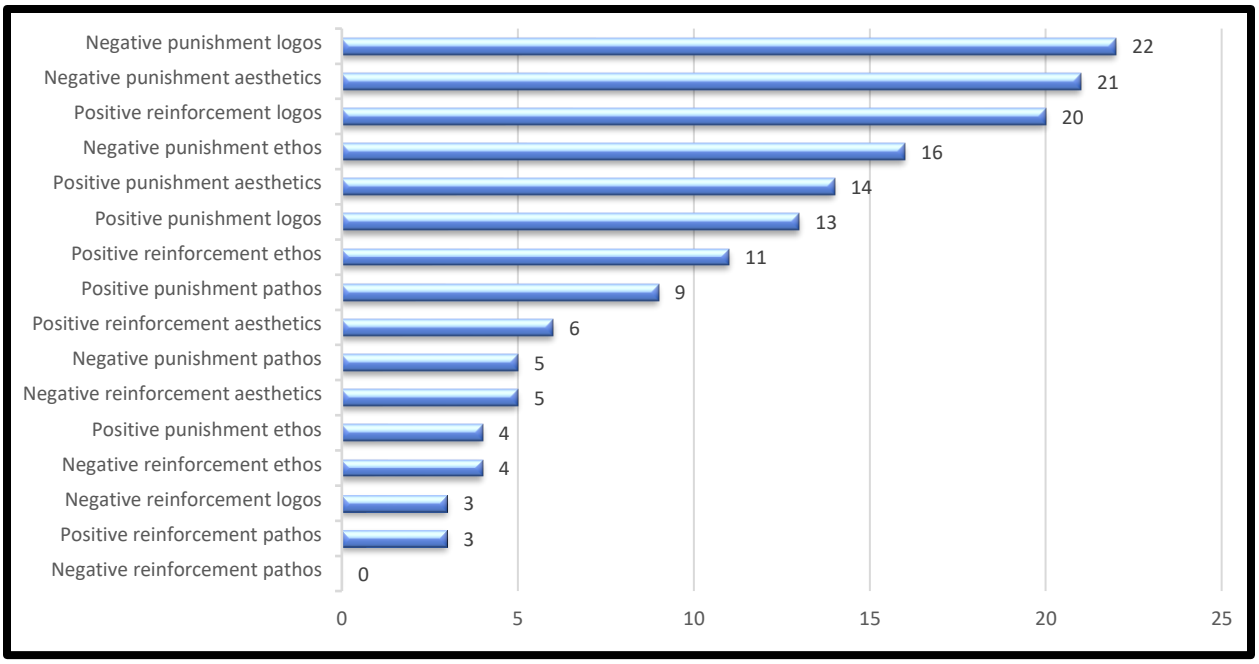


Figure 3.2 Survey results for number of participants belonging to each of the 16 types of incentives.

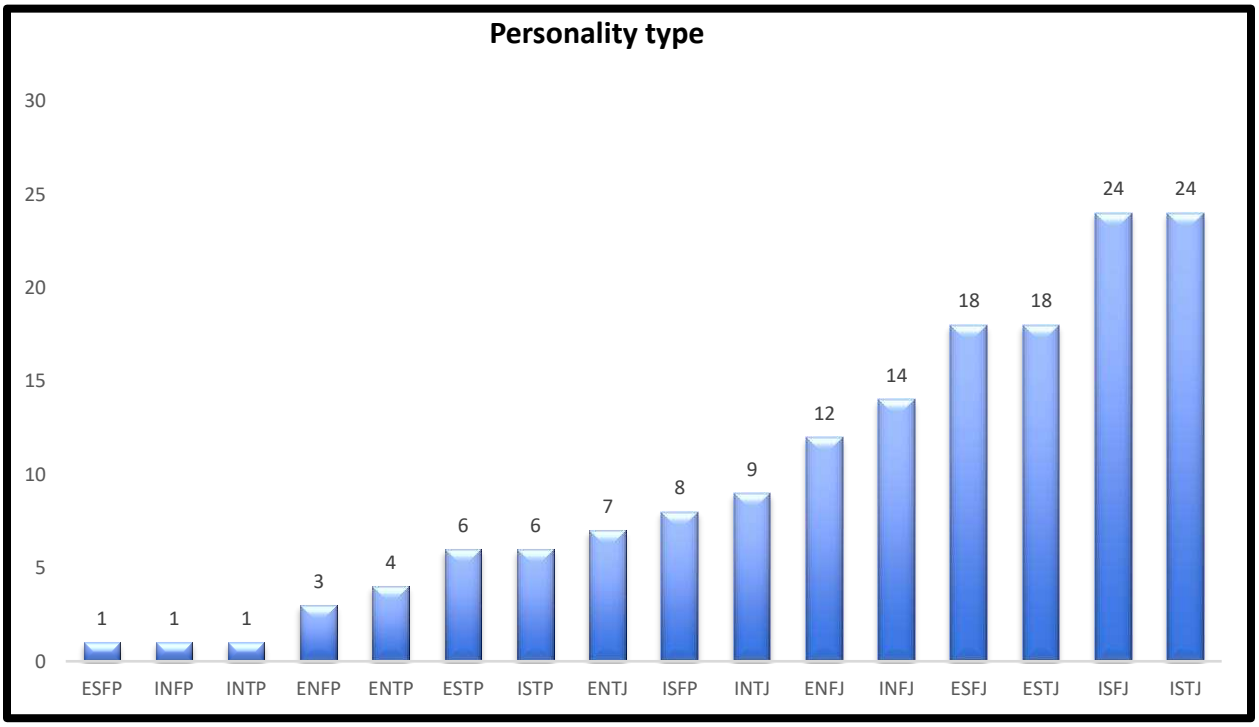


Figure 3.3 Survey results for the number of participants belonging to each of the 16 personality types.

Five Likert scale questions were included in survey #1 for each of the four types of operant conditioning and persuasion types. Weighting from 1 to 5 was assigned to five options of the Likert scale

question (strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree) and participants' preferences were based on the highest scores in their respective categories for the operant conditioning and persuasion question set. Out of 156 responses, 33 responses were indeterminate (same score for two or more categories of operant conditioning or persuasion); therefore, they were excluded from this particular analysis only. Table 3.2 below gives the results for 123 (of 156 possible) responses, which shows that the accuracy between these question sets is less than the expected value.

Table 3.2 Comparison of results from multiple-choice questions to those of Likert scale questions.

	Same Results from Multiple-Choice Questions and Likert Scale Questions (%)	**Different Results from Multiple-Choice Questions and Likert Scale Questions (%)**	**Randomly Expected Value (%)**
Operant conditioning	17.07%	71.54%	25%
Persuasion	28.46%	82.93%	25%

3.3.2.2 Self-Assessments of Questions

This chapter also examines the questions that were asked in survey #1. This analysis is important enough that each question is assessed to check if it is confusing. In order to assess the questions, entropy calculations were performed. Entropy, in simple terms, is a measure of randomness. Entropy calculation is based on the number of responses received by each option that is provided by the question. Entropy is high or maximum for a particular question when the total responses are equally divided between the available options. On the other hand, the entropy of a particular question is low, or near minimum, when

the total responses are focused on only one option from the available options. Equation 3.1 below gives the formula to calculate the entropy [32].

Equation 3.1 Formula to calculate the entropy:

$$e = -\sum_{i=1}^{N} p_i \ln(p_i)$$

Here, I is the particular bin, pi is the percentage of the events in bin (i), and N is the number of bins.

3.3.2.2.1 Likert Scale Question

Survey #1 includes a total of 40 Likert scale questions, wherein each question is intended to evaluate participant preference type. Each Likert scale question consists of five options, as elaborated in the previous analysis. This question type tests participants' views on the question based on agreement or disagreement. Therefore, the expected results for the population of response are to be concentrated around two options (strongly agree or strongly disagree). The higher the entropy of the Likert scale response, the less general agreement there is on a particular question. High entropy in the Likert scale response can also be computed for questions that are less clear. Table 3.3 below gives the question numbers, ranked with respect to their entropy value for each category.

Table 3.3 Calculated entropy results and ranking of questions based on entropy from Likert scale questions evaluating (a) persuasion preference and (b) operant conditioning preference.

(a)				**(b)**			
Question Number	**Entropy**	**Ranking**		**Question Number**	**Entropy**	**Ranking**	
Q11	1.87	1	Logos	Q28	1.99	1	Positive reinforcement
Q9	1.96	2		Q31	2.06	2	
Q7	2.10	3		Q29	2.11	3	
Q8	2.17	4		Q30	2.14	4	
Q10	2.19	5		Q27	2.21	5	
Q16	1.46	1	Ethos	Q36	1.29	1	Negative reinforcement
Q12	1.57	2		Q33	1.48	2	
Q14	1.92	3		Q34	1.98	3	
Q15	1.99	4		Q35	2.04	4	
Q13	2.11	5		Q32	2.16	5	

(a)				(b)			
Question Number	**Entropy**	**Ranking**		**Question Number**	**Entropy**	**Ranking**	
Q20	1.61	1	Pathos	Q41	1.33	1	Positive punishment
Q21	1.95	2		Q39	1.43	2	
Q17	2.03	3		Q40	1.90	3	
Q18	2.06	4		Q38	2.25	4	
Q19	2.09	5		Q37	2.25	5	
Q23	1.77	1	Aesthetics	Q42	1.87	1	Negative punishment
Q25	1.89	2		Q44	2.09	2	
Q24	2.02	3		Q43	2.21	3	
Q26	2.22	4		Q45	2.21	4	
Q22	2.27	5		Q46	2.26	5	

3.3.2.2.2 Multiple-Choice Questions

Survey #1 includes 8 multiple-choice questions, four for operant conditioning preferences and four for persuasion preferences. The entropy method is again used to evaluate the multiple-choice questions for confusion. However, in this case, a single question compares four categories. Therefore, the expected results for the population of responses are to be distributed over the four available options. The higher the entropy of multiple-choice responses, the less general agreement there is on a particular question. Low entropy in multiple-choice responses can also be computed for questions that are less clear. Table 3.4 provides the question numbers, ranked with respect to their entropy value for each category.

Table 3.4 Calculated entropy results and ranking of questions based on entropy from multiple-choice questions.

Question number	Entropy	Ranking	Comparing
Q49	1.97	1	Persuasion
Q47	1.90	2	
Q48	1.89	3	
Q50	1.87	4	
Q52	1.58	1	Operant conditioning
Q51	1.55	2	
Q53	1.54	3	
Q54	1.44	4	

3.3.2.3 Chi-Square Test

Survey #1 had 12 questions that assessed the personality type of the participant. These questions were asked to identify whether there is any influential relationship between the 16 types of personality and 16 types of incentive. In order to test this hypothesis, a Chi-square test was conducted. The Chi-square test is used to statistically evaluate the goodness of fit between the expected values and measured values.

Equation 3.2 Formula for chi-square test:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

The data were analyzed for four types of personality traits (Energy, Information, Decisions, and Organization) with respect to the four types of persuasion and four types of operant conditions. The results are provided in Table 3.5.

Table 3.5 Chi-square score and p-value results for personality traits with respect to persuasion and operant conditioning.

Personality Traits	**Chi-Square Score and *p*-Value**			
	Persuasion		**Operant Conditioning**	
	Score	***p*-Value**	**Score**	***p*-Value**
Energy (Introversion(I) or Extroversion(E))	0.362	0.9479	9.58	0.0198 *
Information (Intuition(N) or Sensing(S))	5.504	0.1383	7.829	0.0496 *
Decisions (Thinking(T) or Feeling(F))	2.508	0.4736	0.3531	0.9497
Organization (Judging(J) or Perceiving(P))	1.789	0.6712	5.241	0.1549

In Table 3.5, an asterisk (*) indicates that the results are statistically significant at $p \leq 0.05$

Thus, the results demonstrate that Energy and Information traits may have an influential relationship with operant conditioning preference.

3.3.2.4 ANOVA Test

Larson [33] states that "Analysis of variance (ANOVA) is a statistical technique to analyze variation in a response variable (continuous random variable) measured under conditions defined by discrete factors (classification variables, often with nominal levels)." In other words, this chapter uses the ANOVA

test to investigate whether there is any influential relationship between the different types of categories with respect to persuasion preferences or operant conditioning preferences. Tables 3.6 and 3.7 provide a list of dependent variables and independent variables which were analyzed with each other (80 tests in total).

Table 3.6 List of independent variables and dependent variables used in ANOVA test.

Independent variable	Dependent variable
Extrovert (E) &and Introvert (I)	Aesthetics
Intuition (N) and Sensing (S)	Logos
Thinking (T) and Feeling (F)	Ethos
Judging (J) and Perceiving (P)	Pathos
Positive or Negative oriented	Positive Reinforcement
Reinforcement and Punishment	Negative Reinforcement
Operant conditioning (4 types)	Negative Reinforcement
Appeal (4 types)	Negative Punishment
Personality type (16 types)	
Motivation approach (16 types)	

Table 3.7 Significant results (p-value < 0.05) of ANOVA tests with significance value between dependent variable and independent variables.

Independent Variable	Dependent Variable	Significance Value
Operant conditioning (4 types)	Logos	<0.001
Motivation approach (16 types)	Negative Punishment	0.001
Motivation approach (16 types)	Ethos	0.005
Thinking (T) and Feeling (F)	Negative Reinforcement	0.008
Thinking (T) and Feeling (F)	Negative Punishment	0.008
Motivation approach (16 types)	Logos	0.01
Extrovert (E) and Introvert (I)	Negative Reinforcement	0.016
Personality type (16 types)	Ethos	0.019
Intuition (N) and Sensing (S)	Logos	0.041

The main purpose of this test was to identify whether there is any statistically meaningful relationship between different categories with respect to persuasion or operant conditioning preference. The results in Table 3.7 give all the possible influential relationships that are possible and are significant.

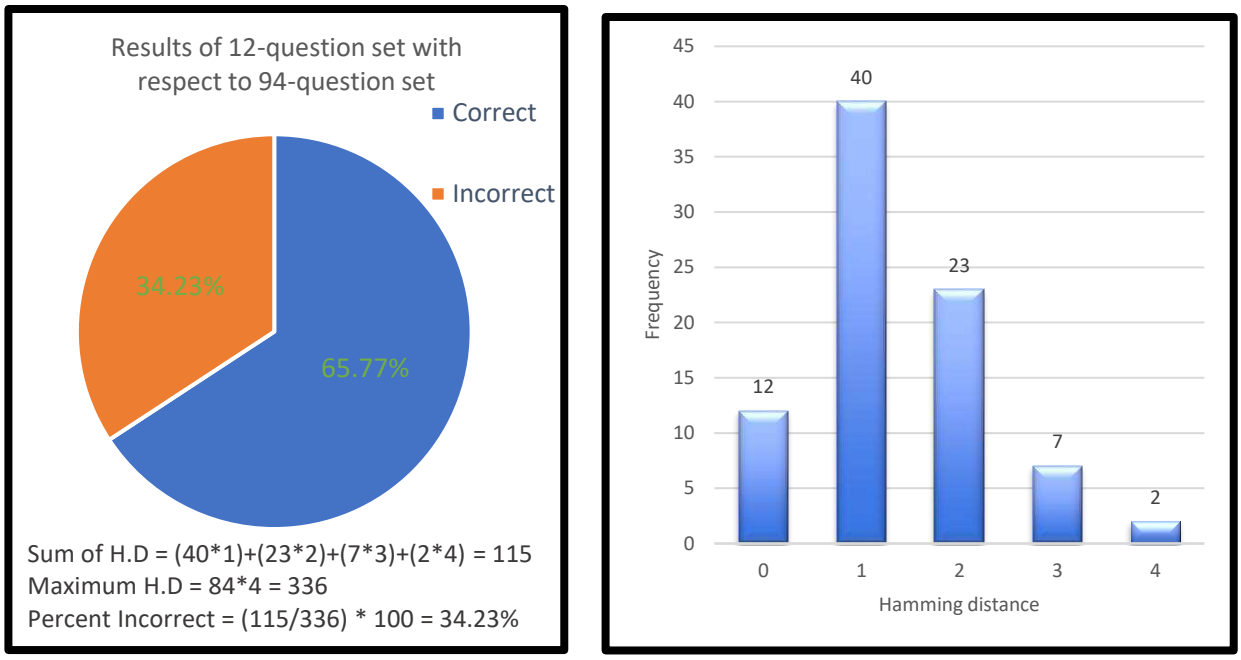
3.3.2.5 Hamming Distance for Personality Test

Hamming [34] proposed this method to estimate the error in telecommunication by counting the number of flipped bits in a binary word. The sum of unmatched bits is the Hamming distance. Saad et al. [35] states that the "Hamming distance is known for its ability in calculating the difference between two sets/elements". Smaller Hamming distances correspond to a closer similarity between two elements. The Hamming distance is used to evaluate and compare the personality type questions. Two types of question sets are compared here. In the first type, participants were asked 12 questions in order to assign a personality type. In the second type, participants were provided with a single qualitative question with an external link to the official website of 16 personalities [36] where participants answered 93 questions to find their personality type and entered their results as an answer to this question. Thus, this chapter compares the results of the 12-question set with the 96-questions set. The Hamming distance is calculated by comparing two words in a letter-to-letter format to find out the discrepancies between them. Table 3.8 provides an example comparing two results from both question sets.

Table 3.8 Example for Hamming distance calculation.

12-Question set	E	N	F	J
93-Question set	I	N	F	P
Hamming distance	1	0	0	1

The Hamming distance for the above example is 2 because of discrepancies in the first and last categories (Energy and Organization). Figure 3.4 shows the results for 84 participants who reported their personality type from the 93-question set. As seen in Figure 3.4 a & b, when the 12-question set was compared to an extensive 93-question set, the 12-question set resulted in 65.8% agreement when compared using the Hamming distance. Out of 84 cases, there were 40 cases wherein the difference between the personality type was just a single letter (a trait in terms of personality category).



(a) (b)

Figure 3.4 (a) Results for percentage correct and incorrect when 12-question set is compared to the 93-question set; (b) results for Hamming distance for personality test comparing 12-question set to 93-question set.

3.3.3 Survey #2 Results and Analysis

Survey #2 was sent to the participants of survey #1 (156 individuals) as a follow-up survey. Out of 156 participants, 96 participants responded to survey #2 (it was active for 54 days). Thus, survey #2 had a response rate of 61.5%. Qualtrics was used again to create the survey and to collect the responses online. The median time to complete survey #2 was 8.25 min. After completion of survey #2, the participants received an email about their personality type, persuasion preferences, and operant conditioning preferences, which were determined by their responses to survey #1 and survey #2.

The survey #2 results and analysis can be divided into four parts, as given below in the sections labeled (Sections 3.3.3.1–3.3.3.3).

3.3.3.1 Quantitative Analysis—Persuasion Approach

Survey #2 included multiple-choice questions that asked about how much would be required, in terms of a monetary incentive, for a participant to select a different operant condition rather than their

identified preferred operant condition. There were 12 questions for 6 transitions in both directions, as explained below:

- Positive reinforcement <-> Negative reinforcement
- Positive reinforcement <-> Positive punishment
- Positive reinforcement <-> Negative punishment
- Negative reinforcement <-> Positive punishment
- Negative reinforcement <-> Negative punishment
- Positive punishment <-> Negative punishment

Table 3.9 gives results for these 12 questions, which are categorized with respect to the persuasion type used to move one's preference of operant condition.

Table 3.9 Results of cost in $ for the transition from one operant condition to another operant condition by using different types of persuasion.

	Cost in $ with Respect to Persuasion Type			
Transition	**Aesthetics**	**Ethos**	**Logos**	**Pathos**
Pos. Rein to Neg. Rein	2.33	1.84	2.65	2.56
Neg. Rein to Pos. Rein	2.47	2.16	2.53	4.44
Pos. Rein to Neg. Punish	2.60	1.63	2.85	2.11
Neg. Punish to Pos. Rein	2.27	2.16	2.29	2.11
Pos. Rein to Pos. Punish	2.73	1.74	2.82	2.11
Pos. Punish to Pos. Rein	2.27	1.84	2.35	3.00
Neg. Rein to Pos. Punish	2.47	1.74	2.88	1,67
Pos. Punish to Neg. Rein	2.47	1.95	2.65	3.22
Neg. Rein to Neg. Punish	2.40	1.74	2.71	2.56
Neg. Punish to Neg. Rein	2.20	1.53	2.12	2.56
Pos. Punish to Neg. Punish	2.73	1.84	2.76	2.56
Neg. Punish to Pos. Punish	2.47	1.32	2.85	2.11
Mean for transition	2.45	1.79	2.62	2.58

3.3.3.2 Quantitative Analysis—Operant Conditioning Approach

In the survey #2 questionnaire, one question was asked to every participant to identify how much money they would require to be motivated for sustainable efforts in their own preferred incentive type,

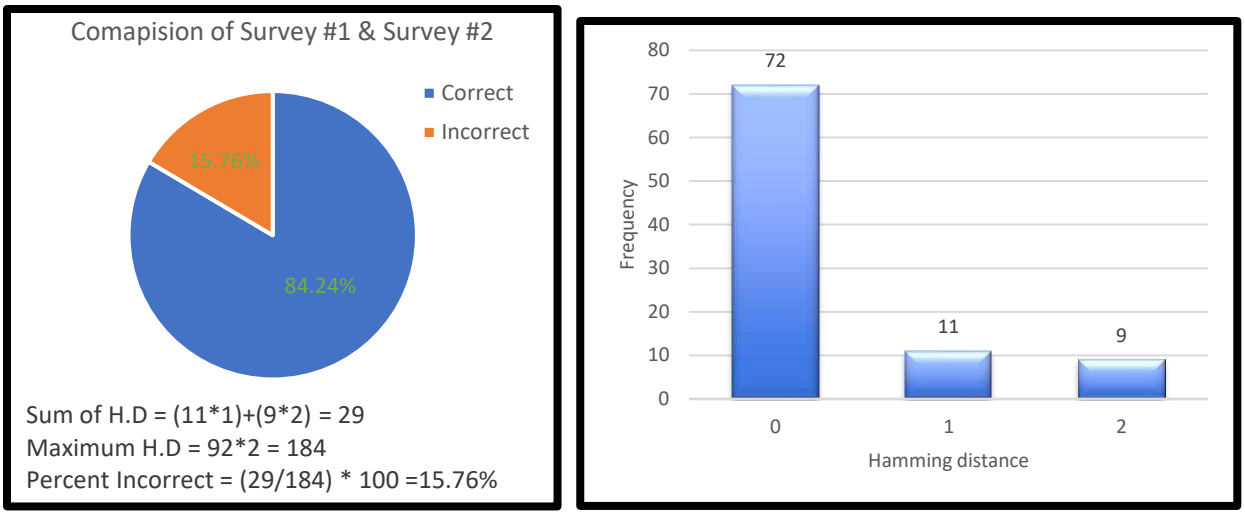
which was determined in survey #1. The question was based on the participant's preferred operant conditioning type. Table 3.10 provides the result for this question, which is given by calculating the mean monetary incentive for each category of operant conditioning.

Table 3.10 Results of amount of monetary incentive required per box for participants to stay in their preferred operant condition.

Operant Conditioning	**Cost ($/Box)**
Positive Reinforcement	1.81
Positive Punishment	2.10
Negative Reinforcement	2.17
Negative punishment	2.41

3.3.3.3 Comparing Survey #1 to Survey #2

The analysis of survey #1 provided the persuasion preferences and operant condition preferences of the participants. From Survey #2, the participants' responses were examined to determine the operant-conditioning-based question for which they selected the least amount of money to reuse the corrugated boxes. Based on their response, an operant conditioning preference was inferred. Thus, participants' operant conditioning preferences based on survey #1 and survey #2 were compared and a Hamming distance was used for their analysis. Below are the results of the Hamming distance. As shown in Figure 3.5, 84.2% of the time, the operant conditioning results (positive vs. negative, reinforcement vs. punishment) were in agreement after comparing operant conditioning preferences from both surveys for each participant. Additionally, it can be seen from the bar graph that out of 92 cases, there were 72 cases (78.3%) wherein the difference between the operant conditioning preferences in terms of Hamming distance is zero.



(a) (b)

Figure 3.5 (a) Results for percentage correct and incorrect on comparing operant conditioning preferences from both surveys; (b) results for Hamming distance on comparing both surveys for operant conditioning preferences.

3.3.3.4 Qualitative Analysis

As the qualitative questions were optional, out of the 96 responses to survey #2, only 32 participants answered the qualitative questions. Qualitative questions allow for the collection and study of the reasoning behind the answers to the quantitative questions, as well as of the whole study. Below is the summary of the responses to these questions –

- The most-mentioned comment by participants was that they do not need any special incentive and would reuse the cardboard boxes voluntarily.
- Participants selected $3 because it is a good balance between $1 and $5.
- Participants felt like threatening (positive punishment and/or negative punishment) is not a good method of providing incentive and they did not like it.
- Participants had questions and comments on practicality, such as the space that the box would require in their home and the effort of finding someone who would be in need of the boxes and then donating it to them.

- Participants thought that when there is a risk of being threatened, reminding them to reuse is important.
- The point of the survey was confusing to a small set of participants.
- Participants thought that there is a risk in reusing a box as they speculated that it would break during transit.

3.4 Discussion

There were 40 Likert scale questions asked in survey #1, designed to cover the possibility of any type of customization that may be required for incentivization. The results of Table 3.2 indicate that when both the multiple-choice questions and the Likert scale questions are compared, their percentage accuracy (eliciting the same results) is less than that of the randomly expected value (25%). Using entropy, the questions asked in survey #1 were evaluated. It was important to assess the questions to find out if they included leading/confusing questions that might affect the results. Assessing the questions based on entropy helps to set a baseline for future researchers or for a researcher who is trying to replicate this research. Table 3.3 compares Likert scale questions to each other with respect to entropy. It can be stated that Q11, Q16, Q20, and Q23 are the least confusing questions in the logos, ethos, pathos, and aesthetics categories, respectively, or that they have the greatest overall agreement among survey respondents. Questions Q28, Q36, Q41, and Q42, by the same measure, are the least confusing questions for the positive reinforcement, negative reinforcement, positive punishment, and negative punishment categories, respectively. Table 3.4 compares multiple-choice questions based on entropy, and it can be stated that Q49 for persuasion and Q52 for operant conditioning are the least confusing questions, respectively, or that they have the least agreement among respondents.

This chapter also evaluated whether there is an influential relationship between the 16 types of personality and the 16 types of incentive. The results for the chi-square test from Table 3.5 indicate that

the 16 types of personality have no strong influential relationship with the 16 types of incentive. In order to see if there is any influential relationship between different types of variables, an ANOVA test was carried out. Table 3.7 gives the significant results that were found by comparing ten independent variables with 8 dependent variables. These results indicate that there are differently influenced subpopulations. Survey #1 also introduced a 12-question set to elicit the personality type of the participant. This 12-question set was then compared to the more traditional 93-question set. The accuracy of the 12-question set was found to be 65.8% using the Hamming distance. Thus, the main result of survey #1 was to develop a generic method of incentivization for the general population. Building on that result, survey #2 was conducted to elicit how much it would cost to incentivize the general population to adopt sustainable efforts. Survey #2 evaluated the cost factor of the incentives and an incentivization method that was cost-effective as well as being motivational to the general population for sustainable efforts. From Table 3.9, it can be argued that the "ethos" persuasion technique was the most cost-effective method to motivate participants to change their preferred operant conditions, while still motivating them to adopt sustainable efforts. Similarly, from Table 3.10, in terms of operant conditioning, "positive reinforcement" appeared to be the most cost-effective method for sustainable efforts. In order to motivate the general population towards sustainable efforts, "positive reinforced ethos" was, based on the results presented here, an effective yet cost-efficient method of incentivizing the general population. One of the pieces of feedback from the qualitative questions was about not liking the positive punishment and negative punishment types of incentive. This further supports the recommendations of the study, which is to use ethos and positive reinforcement to influence people to reuse CCBs.

There were no similar studies found in the literature review, where incentives were used for the "reuse" process over the recycling process for the general population. Past and current research have tried to incentivize the general population to make a sustainable effort such as recycling waste [15,16,19,37]. The authors of papers [38–40] talk about indirect incentives to the general population

based on waste management service charges. The authors of [38–40] test the effects of indirect financial incentives by using pay-by-weight or pay as you throw (PAYT) which means to pay a customized trash service fee instead of a fixed service that depends on the weight of the trash. All three reference papers conclude that incentives do make a positive difference in the current situation. Reference [41] talks about the use of financial incentives in terms of virtual currency to motivate the general population to increase plastic recycling. Thus, research that yields a unique method and cost to motivate the general population was not found.

One of the issues/challenges for the proposed method is how the general population would accept that the packaging they are using/received has been reused multiple times. Another challenge is installing a new system to collect and store the used corrugated boxes: this will be a challenge as they would need to be handled gently compared to other waste of recycling goods and would require more storage space as boxes would need to be in their proper forms to be reused again. Lastly, the feasibility of using a corrugated box multiple times to carry packages would need to be explored and researched. Although it has been observed that corrugated boxes can be used 20–30 times to transport products in an industrial setting [42,43], research on the reuse of corrugated boxes outside of industrial use can be explored in the future.

3.5 Conclusions

The purpose of the research in this chapter was to find a way to motivate the general population to adopt more sustainable efforts. This chapter addressed finding a low-cost solution to incentivize the general population. Considering the results and analyses, it can be concluded that segmenting the general population based on different personality types and motivational attributes such as persuasion and operant condition types would not add significant value in motivating them to reuse the corrugated packaging. Survey #2 also tested the consistency of participants' preferences, as survey #2 had small changes in the questions to evaluate fine-tuned sensitivity for different ways of incentivizing while

comparing two incentives. It was expected that the participants would change their preference or confuse their preference from survey #1; however, this was not observed. In fact, participants were consistent with their views from survey #1 while answering survey #2.

It can be observed that incenting the general population with a generic method appears to be more effective than trying to craft a customized method for a specific set of people grouped by the persuasion, operant conditioning, and personality types explored. Thus, the recommendation from this research would be to use “positive reinforcement + ethos” as an incentive to motivate the general population to reuse the corrugated boxes instead of recycling them. The recommendation and output from this chapter may impact the mindset of the general population to reuse their own corrugated boxes and those of others, rather than placing the corrugated boxes into the normal flow of the trash or recycling.

The future scope and prospects of this study include how to put across the message of the incentive, to evaluate how to better incentivize the general population. Framing the incentive message to be more efficient and effective is important. Furthermore, this study could act as a basis for future studies. There is a strong possibility of the use of these paired sets of incentive approaches for sustainable cars, solar panels, vaccinations, etc. The authors have also made sure to evaluate their questions from the survey, so that future researchers can replicate or use the questionnaire (included in Appendices B and C), accordingly, for future studies.

4 A LIFECYCLE ANALYSIS AND ECONOMIC COST ANALYSIS OF CORRUGATED CARDBOARD BOX REUSE AND RECYCLING IN THE UNITED STATES

4.1 Introduction

The current lifecycle of corrugated cardboard boxes (CCB) starts with the manufacturing of the CCBs with raw materials such as hardwood, softwood, and adhesives. These raw materials are collected and transported to the location of the pulp-making operation. The pulp is made out of softwood and hardwood to form fibers which are then combined with recycled fibers to manufacture paper. Next, the manufactured paper is transported to the location of the converting operation. Two types of paper are used in manufacturing the CCBs: liner and medium. CCBs comprise a corrugated board that is made up of three layers of corrugated sheets (an inside liner, an outside liner, and a medium that goes between the two, which is fluted). The corrugated board is formed in the required shape and size of CCBs. Once the CCBs are formed, they are shipped to the required location (e.g., retail stores), where they start their use phase. In this phase, they are mainly used as outer packaging material for the transportation and shipping of goods and products. In the disposal phase, the CCBs are either recycled or landfilled. A huge amount of the supply chain goes into extracting raw materials, such as cutting hardwood and softwood trees and processing them. Additionally, extraction plays a role in the recycling phase, where the recycled fibers are extracted from old CCBs.

The previous chapter laid the groundwork for this chapter. This previous work discussed pollution and the current efforts to reduce global warming and climate change. It focused on recycling waste and the two main shortcomings of recycling corrugated cardboard boxes (CCB). First, out of 100 billion boxes produced in the U.S. each year, only 70–75% of the boxes are received for recycling [4,5]. Second, a typical CCB contains only 50% of its fibers from recycled fibers [9,10]. Previous work showed that one of the main

reasons for the low recycling rate is the lack of motivation in the general population. In order to address this, the authors proposed a way to "reuse" the CCB instead of recycling it in addition to testing different types of motivation tools. Previous chapter proposed a new motivation means by combining persuasion techniques (ethos, pathos, logos, and aesthetics) and operant condition techniques (positive reinforcement, positive punishment, negative reinforcement, and negative punishment). After conducting two surveys and analyzing the data with various tools, the chapter recommended using "positively-reinforced ethos" as an incentive for the general population to reuse the CCB over recycling or landfilling it. Lastly, the chapter also gave the cost of positive reinforcement ($1.81) and the cost of ethos ($1.79). This mean value is used in this study, with the cost of motivating the general population using positive reinforcement ethos being assigned a value of $ 1.80. The proposed "reuse" cycle includes the general population allocating the CCB they received to "reuse" containers. Then these boxes would be collected by a truck and transported to the location where the CCBs are checked and resold to the general population. When the CCBs are not in a condition to be reused, they are assigned to recycling. Reuse is generally thought to be more sustainable for industries because it will eliminate/decrease certain supply chains and/or extraction of raw materials. Thus, it is important to examine if the environmental and economic cost of reducing the extraction is able to offset the additional cost of recollection and incentives.

Thus, the previous chapter answers questions on motivation and incentives that will work to motivate the general population to reuse and the cost of the incentive to motivate. However, from a systems standpoint, it is also (possibly more) important to determine the amount of carbon that is saved by reusing the CCB instead of recycling it or landfilling it. Moreover, is the reusing process economically feasible? Thus, this chapter evaluates the carbon emission of CCB with different disposal scenarios (reusing, recycling, and landfilling). It will also evaluate the economic aspects of the "reuse" process to test its economic feasibility.

4.2 Materials and Methods

There are many methods to evaluate the carbon emission of a product. Based on the scope, it can be broadly categorized into two types, cradle-to-gate and cradle-to-grave. The cradle-to-gate method includes all the pollution from raw material gathering to packaging and shipping of the final product. It excludes the use phase and disposal phase. The cradle-to-grave method, in contrast, includes all the emissions over the entire life of the product.

4.2.1 Lifecycle Assessment

A Life Cycle Assessment (LCA) approach was used to calculate the carbon emission of CCB over its life cycle. Ref. [44] defines an LCA as "an environmental accounting and management approach that considers all the aspects of resources use and environmental releases associated with an industrial system from cradle-to-grave." The lifecycle of a corrugated cardboard box can be divided into four parts: pulp-making, converting, use phase, and end of the lifecycle. To calculate the carbon emission in these stages and to estimate total carbon emission over the life cycle of a corrugated cardboard box, LCA is carried out. The LCA methodology used in this research follows the international organization for standardization's ISO 14040 and ISO 14044. The methodology to conduct an LCA consists of four steps:

- Set Goal and Scope;
- Life Cycle Inventory (LCI) Analysis;
- Life Cycle Impact Assessment (LCIA);
- Interpretation of Results.

4.2.1.1 Set Goal and Scope

The main product under study is a single-walled corrugated cardboard box. A recent study [10] conducted by Fibre Box Association shows that an average corrugated cardboard box is made up of 50 % recycled fibers. Thus, the product that is modeled and considered in this study is assumed to be

manufactured with 50% recycled fibers. The function assumed for the product under this study is the domestic use of the average corrugated cardboard box produced in the U.S., namely, that of using the corrugated box mainly as a secondary packaging of products for shipping and transportation. The functional unit is defined as the domestic use of 1 kg of an average single-walled corrugated cardboard box produced in the United States. The goods that the corrugated cardboard box would carry are not considered in this study.

The system boundary includes the following four steps of the lifecycle of the corrugated box, which is set concerning a cradle-to-grave approach, i.e., from raw material extraction to the disposal of the product:

1. Pulp-making: This includes forest operations (cutting down the trees), transportation of the wood, chipping operation (converting wood into small chips), production of pulp from the chips, paper-making operation from pulp, conversion into a roll, and all the support operations such as steam/heat generation, chemical generation, etc.
2. Converting: This includes the transportation of paper to converting operations, the converting operation, which includes converting the liner board and corrugated medium into a corrugated box, and all the other supporting operations.
3. Use: This includes the transportation to use phase and the assumed transportation of the box in its use phase.
4. End-of-lifecycle (EoL): This includes the transportation of corrugated boxes from the use phase to the EoL phase and the energy and emission from the EoL processes such as landfilling, recycling, and burning.

Capital equipment, maintenance, transport of employees, and operation of support equipment are not included in the scope of this study. The energy required to pack a product in the use phase is also

not considered in the scope. Wood and coal ashes are considered residual waste in the production process of CCB. The co-products—turpentine and tall oil—that are produced during the manufacturing process of CCB are very small in number and quality compared to CCB. Thus, co-product allocations are ignored as different allocation procedures are likely to have insignificant effects on the results.

4.2.1.2 Life Cycle Inventory Analysis

In the Life Cycle Inventory Analysis step, a description of the material used in the lifecycle of the product is expected. It also includes energy flows within the system as well as the system's interaction with the environment. The life cycle inventory data for a corrugated cardboard box is taken from a report [2] published by NCASI in 2017 as a reference, and the model is built upon it. The reference report has collected data with the help of surveys from corrugated cardboard manufacturing industries in the United States. Inventory data is divided in terms of stages of the lifecycle and are specified below.

4.2.1.2.1 Pulp-Making Phase

The pulp-making process consists of many different processes, inputs, and outputs that are outlined in Figure 4.1.

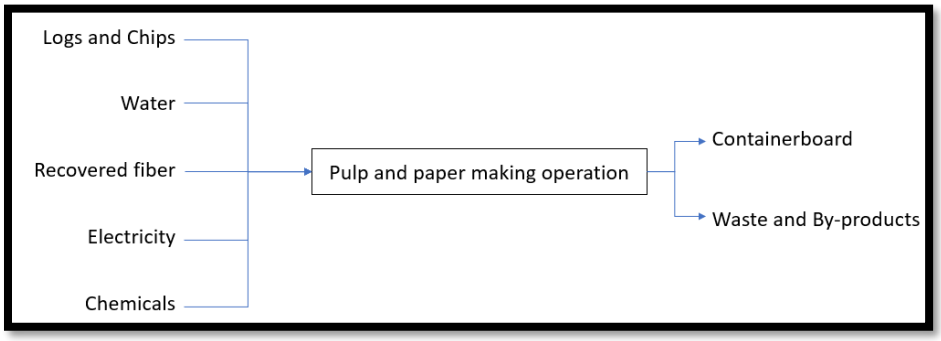


Figure 4.1 Inputs and outputs of pulp and paper-making operation.

Thus, the above figure outlines a part of the life cycle process of the corrugated box, from raw materials such as wood logs and wood chips to the end product of the containerboard. It also specifies

the energy consumed as well as the byproducts of this process. It is also important to specify the input-output to the production of the containerboard unit process per functional unit, as given in Table 4.1.

Table 4.1Input/Output material and energy for production on containerboard [2].

Input/Output	Quantity	Unit
INPUTS		
Resources		
Water intake	30.9	kg
Fiber raw material		
Hardwood logs	0.14	kg
Softwood logs	0.58	kg
Purchased hardwood chips	0.10	kg
Purchased softwood chips	0.32	kg
Recovered fiber	0.57	kg
Chemicals		
Sodium hydroxide (Caustic)	7.6×10^{-3}	kg
Sulfuric Acid	1.2×10^{-2}	kg
Aluminum Sulfate	2.7×10^{-3}	kg
Starch	5.4×10^{-3}	kg
Lime	9.0×10^{-3}	kg
Soda	3.6×10^{-3}	kg
Pitch dispersant	6.0×10^{-5}	kg
Strength agents	7.0×10^{-3}	kg
Other fillers	5.5×10^{-3}	kg
Energy		
Electricity	8.55	MJ
Purchased power	1.66	MJ
Purchased steam	0.77	MJ
OUTPUTS		
Products and co-products		
Containerboard	1.10	kg
Turpentine and tall oil	0.017	kg
Sold power	0.07	kWh
Emission to air		
Nitrogen oxides (NOx)	1.56×10^{-3}	kg
Sulfur oxides (Sox)	1.15×10^{-3}	kg
Total reduced sulfur (TRS), as H_2S	7.71×10^{-5}	kg
Particulates	6.11×10^{-4}	kg
Carbon monoxide (CO)	2.57×10^{-4}	kg
Carbon dioxide (CO_2), biogenic	1.23	kg
Carbon dioxide (CO_2), fossil	0.331	kg
Methane (CH_4), biogenic	1.22×10^{-3}	kg
Methane (CH_4), fossil	1.3×10^{-5}	kg
Nitrous oxide (N_2O)	5.01×10^{-5}	kg

Input/Output	Quantity	Unit
Evaporated water	3.67	kg
Emissions to water		
Process effluent	26.8	kg
Cooling water discharges	1.82	kg
Adsorbable Organic Halides (AOX)	4.21×10^{-6}	kg
Biochemical oxygen demand (BOD5)	9.73×10^{-4}	kg
Total suspended solids (TSS)	1.34×10^{-3}	kg
Total nitrogen	2.04×10^{-4}	kg
Total phosphorus	3.45×10^{-5}	kg
Residuals		
Wastewater treatment plant residuals	0.036	kg
Wood ashes	0.023	kg
Coal ashes	0.006	kg
Other solid wastes	0.049	kg

4.2.1.2.2 Converting Phase

Converting process consists of many different processes that are outlined in Figure 4.2.

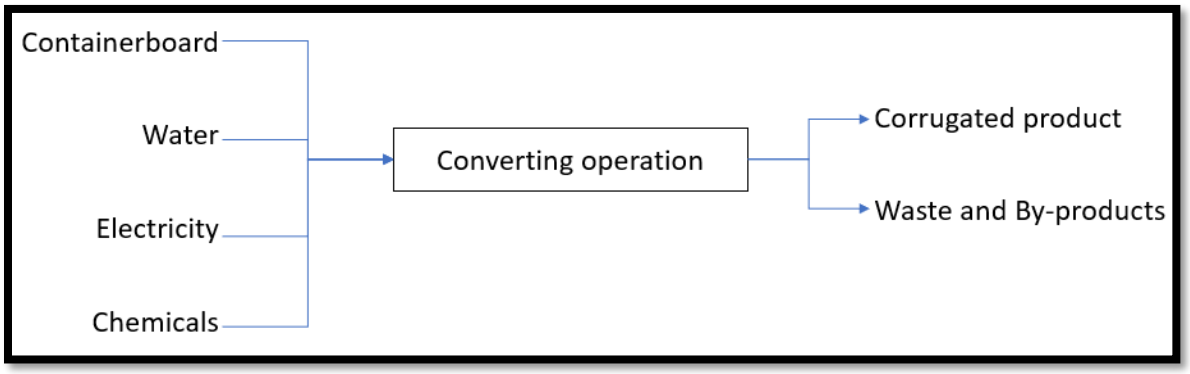


Figure 4.2 Inputs and outputs of converting operation.

Thus, the above figure outlines the life cycle process of the corrugated box's converting process, which gets the containerboard as input from the pulp-making step, which is then converted to a corrugated cardboard box. It also specifies the energy consumed as well as the byproducts of this process. It is also important to specify the input-output to converting unit process per functional unit, as given in Table 4.2 below.

Table 4.2 Input/Output material and energy for production on corrugated boxes [2].

Input/Output	Quantity	Unit
INPUTS		
Resources		
Water intake	0.457	kg
Fiber raw material		
Containerboard	1.10	kg
Chemicals		
Starch	2.00×10^{-2}	kg
Wax	3.76×10^{-3}	kg
Ink	1.30×10^{-3}	kg
Adhesive	1.61×10^{-3}	kg
Coating	5.13×10^{-4}	kg
Borax	3.03×10^{-4}	kg
Resin	3.38×10^{-4}	kg
Sodium hydroxide (Caustic)	5.51×10^{-4}	kg
Energy		
Electricity	1.40	MJ
Purchased power	0.142	MJ
Purchased steam	2.41×10^{-3}	MJ
OUTPUTS		
Products and co-products		
Corrugated cardboard box	1.0	kg
Emission to air		
Nitrogen oxides (NOx)	5.09×10^{-5}	kg
Sulfur oxides (Sox)	1.03×10^{-6}	kg
Particulates	4.37×10^{-5}	kg
Carbon monoxide (CO)	5.44×10^{-5}	kg
Carbon dioxide (CO_2), fossil	8.51×10^{-2}	kg
Methane (CH_4), fossil	1.46×10^{-6}	kg
Nitrous oxide (N_2O)	2.37×10^{-7}	kg
Non-methane VOCs	1.39×10^{-4}	kg
Evaporated water	0.215	kg
Emissions to water		
Effluent, direct	0.0133	kg
Effluent, indirect and other	0.252	kg
BOD, direct	4.53×10^{-6}	kg
TSS, direct	2.52×10^{-6}	kg
Residuals		
Converting losses to recycling	0.125	kg
Other solid wastes	0.049	kg

4.2.1.2.3 Use Phase

This phase consists of the use of the corrugated box to ship other products by various consumers. Calculating carbon emission for this phase is very difficult, as it depends on the content inside the corrugated box and distance, as well as the mode of transport used for shipping purposes. Thus, certain assumptions are made to calculate carbon emissions in this phase. The United States Census Bureau's data on commodity flow is used as the reference data to calculate the shipping distance of a representative corrugated box in the United States. This data was published in 2017 in the CFS preliminary report: Shipment characteristics by total modal activity [45]. Below is the available data in Table 4.3.

Table 4.3 Data from 2017 CFS preliminary report: Shipment characteristics by total modal activity.

Mode of Transport	Year	Ton-Miles (Millions)	Ton-Miles (Percent of Total)	Average Miles per Shipment
Truck	2017	1,347,240	43	186
Rail	2017	1,460,158	46.6	969
Water	2017	216,794	6.9	439
Air	2017	6560	0.2	1006
Other	2017	27,189	0.8	886

4.2.1.2.4 End-of-Lifecycle

The End-of-Lifecycle of the corrugated cardboard box is modeled with respect to the data from the United States Environmental Protection Agency (EPA) from 2018 as shown in Table 4.4 [6].

Table 4.4 Total paper and paperboard containers and packaging in MSW by weight (in thousands of U.S. tons).

Management Pathway	2000	2005	2010	2015	2017	2018
Generation	39,940	39,640	37,680	39,920	41,060	41,900
Recycled	21,040	23,610	26,850	31,200	30,080	33,890
Composted	-	-	-	-	-	-
Combustion with Energy Recovery	3670	2920	1920	1710	2160	1570
Landfilled	15,230	13,110	8910	7010	8820	6440

Thus, the end of the life cycle of corrugated cardboard boxes is modeled with respect to the recently available data from 2018. Recycling of CCB is 80.88%, landfill of CCB is 15.37%, and combustion of CCB is 3.75%. Apart from the material use and energy consumption data, it is also important to specify the reference data on the electricity generation and transportation values used as assumptions for modeling. Data on the U.S. average electricity grid fuel consumption mix used for 2021 is shown in Table 4.5 below (U.S. Energy Information Administration) [46].

Table 4.5 U.S. utility-scale electricity generation by source, amount, and share of the total in 2021.

Energy Source	**Billion kWh**	**Share of Total**
Total—all sources	4108	
Fossil fuels (total)	**2508**	**61.0%**
Natural gas	1579	38.4%
Coal	898	21.9%
Petroleum (total)	19	0.5%
Petroleum liquids	12	0.3%
Petroleum coke	8	0.2%
Other gases	11	0.3%
Nuclear	**778**	**18.9%**
Renewables (total)	**815**	**19.8%**
Wind	378	9.2%
Hydropower	252	6.1%
Solar (total)	115	2.8%
Photovoltaic	112	2.7%
Solar thermal	3	0.1%
Biomass (total)	54	1.3%
Wood	36	0.9%
Landfill gas	9	0.2%
Municipal solid waste (biogenic)	6	0.1%
Other biomass waste	2	0.1%
Geothermal	16	0.4%
Other sources	**12**	**0.3%**

All energy used in the input of the operations is considered electricity. Thus, electricity is modeled in OpenLCA, as given in Table 4.6 below.

Table 4.6 Electricity modeling in OpenLCA by source, share, and values.

Energy Source	Share of Total	Pulp-Making Operations (10.98 MJ)	Converting (1.544 MJ)
Coal	21.90%	2.24	0.42
Petroleum	0.50%	0.05	0.01
Natural gas	38.40%	3.92	0.73
Nuclear	18.90%	1.93	0.36
Wind	9.20%	0.94	0.18
Hydropower	6.10%	0.62	0.12
Biomass	1.30%	0.13	0.02
Average Electricity mix	3.80%	0.39	0.07

The amount of electricity is based on the national average (mean) in the United States. Since the database did not include electricity produced from solar, other gases, geothermal, and other sources, they are all added to the "average electricity mix." Data on transportation distances were modeled using the NCASI report [2] from 2017, which is given in Table 4.7 below.

Table 4.7 Transportation data for distance, mode of transportation, and its share.

Material	Truck		Train		Boat, Barge		Boat, Ocean	
	%	km	%	km	%	km	%	km
Wood logs to Pulp & Paper mills	98.4	159	1.6	1577				
Wood chips to Pulp & Paper mills	94.5	299	5.5	1674				
Recovered fiber to pulp and paper mills	85.4	241	12.6	505	2.0	822		
Pulp to pulp and paper mills	80.1	262	19.8	1511				
Chemicals	58.1	217	28.0	1333	12.8	674	1.0	2992
Containerboard to converting	80.1	262	19.8	1511				
Corrugated sheets	80.1	262	19.8	1511				
Corrugated product to use	95.7	283	4.3	2446				

4.2.1.3 Life Cycle Impact Assessment (LCIA)

This step includes describing the selected impact categories for LCA analysis as well as describing the method used to calculate the impact category. There are many impact categories as a list of commonly used categories is specified in ISO 14047 Technical Report (ISO2012a): global warming, human toxicity, stratospheric ozone depletion, depletion of abiotic resources, photo-oxidant formation, nitrification,

ecotoxicity, acidification, and the depletion of biotic resources. Since this study focuses on the carbon emission of 1 kg of corrugated cardboard box over its lifecycle, three impact categories are used as follows:

- Global warming, Fossil;
- Global warming, Biogenic, GWP 20 years;
- Global warming, Biogenic, GWP 100 years.

The impact category listed above are custom-made impact categories that are formed by combining the following standard impact categories:

- GHG Protocol;
- Environmental Footprint;
- IPCC 2013 GWP 20;
- IPCC 2013 GWP 100.

Impact categories depend on the impact factors included in their respective category. Impact factors for the three impact categories used in this study can be made available upon request to the authors at ketkale15@gmail.com. It is important to note that the Global Warming Potential (GWP) values for the impact factors are mainly derived from the Fifth Assessment Report (AR5) of IPCC (IPCC 2013, Table 8.A.1) [47].

4.2.1.4 Interpretation of Results

This step is done in the sub-chapters 4.4.3 and 4.4.4 of this research.

4.2.2 Economic Model

It is also important to look at the economics of reusing corrugated cardboard boxes instead of landfilling them or recycling them. Two concepts are used in this research to study and model the

economics of this proposed "reuse" of corrugated boxes—benefit cost analysis and marginal cost–willingness-to-pay curve.

Benefit-cost analysis is simply a method to evaluate something by considering its potential cost and benefits. According to Ref. [48], "Benefit-cost analysis is for the public sector what a profit-and-loss analysis is for a business firm or a budget is for a household." Benefit-cost analysis is a tool used from society's standpoint to make a public decision instead of a single profit-making firm. The basic framework for benefit-cost analysis is used with reference to Ref. [48], which includes the following four steps:

- Clearly specify the project or program;
- Describe the inputs and outputs of the program quantitatively;
- Estimate the value of social costs and benefits of these inputs and outputs;
- Compare these benefits and costs.

Marginal cost, or willingness-to-pay curves, can simply be imagined as supply and demand graphs with respect to the prediction of demand and ability to supply. According to Ref. [48], a "willingness-to-pay for a given consumption level is the total amount a person would be willing to pay to attain that consumption level rather than go without the good entirely." In other words, willingness-to-pay is the maximum amount an individual is willing to pay to acquire a good/service. According to Ref. [49], "Marginal cost is the increment in cost that occurs when the output produced is increased by one unit." Therefore, marginal cost is the difference in total cost that is experienced when the quantity of production is increased or the cost of producing one additional product is.

4.3 Results

4.3.1 Carbon Emission for Pulp-Making and Converting Operations

LCA modeling was conducted on OpenLCA software version 1.11.0 for pulp-making and converting operations. The databases specified under Table 4.8 were combined and used to model the pulp-making and converting operations.

Table 4.8 List of databases that were combined in OpenLCA.

Database Name	**Source**
Agribalyse v3.0.1	French Agency for Ecological Transition [50]
BioEnergieDat	German BioEnergieDat Project [51]
Ecoinvent v3.7	Ecoinvent [52]
Environmental Footprint v2.0	European Commission's Single Market for Green Products initiative [53]
ELCD v3.2	European reference of Life Cycle Database of the Joint Research Center [54]
Exiobase v3.4	Multi-regional Environmentally Extended Supply and Use/Input-Output database (MR EE SUT/IO) [55]
NEEDS	New Energy Externalities Developments for Sustainability [56]
OpenLCA v2.1.3	OpenLCA [57]
OzLCI 2019	The Evah Institute [58]
Worldsteel_2020 (EF 3.0)	The World Steel Association [59]

Thus, baseline data is used from these databases. OpenLCA is used to calculate the carbon emission for pulp-making and converting operations (excluding transportation). Table 4.9 below shows the results from OpenLCA software for the two phases.

Table 4.9 OpenLCA results for pulp-making and converting operations.

Emission Type	**Pulp-Making ($kgCO_2$-eq)**	**Converting ($kgCO_2$-eq)**
Fossil	2.03313	0.36044
Biogenic (GWP 20 years)	1.33393	-
Biogenic (GWP 100 years)	1.26464	-

4.3.2 Carbon Emissions from Transportation

Carbon emission from the transportation of goods is calculated by using the following formula:

Carbon emission (kgCO2-eq) = (Weight of the product in kg) × (Distance traveled per vehicle/mode of transport in km) × (Emission factor for respective vehicle/mode of transport in kgCO2-eq/kg.km)

The product's weight and travel distance are specified in the Life cycle inventory section. The emission factors are from the United States Environment Protection Agency's GHG emission factors Hub, as shown in reference Table 8 (April 2022) [60]. Below are the results in Table 4.10 and Table 4.11 for the transportation based on phases of the lifecycle.

Table 4.10 Carbon emission from transportation in pulp-making operations.

Material	**Mode of Transport**	**Percentage Used**	**Distance (km)**	**Kg×Km**	**Emission Factor ($kgCO_2$-eq/ kg×km)**	**CO_2 Emission ($kgCO_2$-eq)**
Wood log to P&P mill (0.72 kg)	Truck	98%	159	112.6483	0.00037	0.04217
	Train	2%	1577	18.1670	0.00004	0.00071
Wood chips to P&P mill (0.42 kg)	Truck	95%	299	118.6731	0.00037	0.04442
	Train	6%	1674	38.6694	0.00004	0.00151
Recovered fiber (0.57 kg)	Truck	85%	241	117.3140	0.00037	0.04391
	Train	13%	505	36.2691	0.00004	0.00142
	Boat, Barge	2%	822	9.3708	0.00007	0.00068
Pulp to paper mill (0.005 kg)	Truck	80%	262	1.0493	0.00037	0.00039
	Train	20%	1511	1.4959	0.00004	0.00006
Chemicals (0.04656 kg)	Truck	58%	217	5.8701	0.00037	0.00220
	Train	28%	1333	17.3781	0.00004	0.00068
	Boat, Barge	13%	674	4.0168	0.00007	0.00029
	Boat, Ocean	1%	2992	1.3931	0.00007	0.00010
Total Carbon emission in $kgCO_2$-eq						0.1385

Table 4.11 Carbon emission from transportation in converting operation.

Material	Mode of transport	Percentage used	Distance (km)	Kg×Km	Emission factor ($kgCO_2$-eq/ kg×km)	CO_2 emission ($kgCO_2$-eq)
Chemicals (0.0283 kg)	Truck	58%	217.00	3.5774	0.00037	0.00134
	Train	28%	1333.00	10.5907	0.00004	0.00041
	Boat, Barge	13%	674.00	2.4480	0.00007	0.00018
	Boat, Ocean	1%	2992.00	0.8490	0.00007	0.00006
Containerboard (1.1 kg)	Truck	80%	262.00	230.8482	0.00037	0.08641
	Train	20%	1511.00	329.0958	0.00004	0.01284
Corrugated sheets (1 kg)	Truck	80%	262.00	209.8620	0.00037	0.07855
	Train	20%	1511.00	299.1780	0.00004	0.01168
Corrugated product to use (1 kg)	Truck	96%	283.00	270.8310	0.00037	0.10138
	Train	4%	2446.00	105.1780	0.00004	0.00410
Total Carbon emission in $kgCO_2$-eq						0.2970

4.3.3 Carbon Emission for Use Phase

It is difficult to identify/calculate the distance traveled by an average CCB and its mode of transport. In general, corrugated cardboard boxes are mainly used for packaging and transporting products. Usually, this phase is ignored, and the carbon emission from the use phase of CCB is allocated to the product that CCB holds for the sake of its transportation. To approximately calculate carbon emissions from this phase, the mean distance traveled by the average corrugated box with respect to the mode of transport is given in Table 4.12 which is obtained from the United States Census Bureau's CFS

Preliminary Report (CF1700P2): Shipment characteristics by total modal activity (2017) [45]. Here, the mass of the product is considered to be 1 kg as the functional unit in this research is 1 kg of CCB.

Table 4.12 Carbon emission in the use phase for CCB.

Mode of Transportation	**Average Distance Traveled (mile)**	**Emission Factor in $kgCO_2$-eq/kg-Mile**	**Emission ($kgCO_2$-eq)**
Truck	186	0.00023	0.0433
Rail	969	0.00002	0.0235
Air	1006	0.00128	1.2919
Water	439	0.00005	0.0198
Total Carbon emission in $kgCO_2$-eq			1.3785

4.3.4 Carbon Emission for the End-of-Lifecycle (EoL) Phase

To calculate carbon emission at the EoL phase of 1 kg of CCB, it is important to understand the waste management methods used and emissions from respective methods. The reference data from 2018 is specified under the lifecycle inventory step in Table 4.4. Out of the total waste collected, 81% is recycled, 4% is combusted, and 15% is landfilled. To calculate the carbon emission from each of the above management pathways, the authors use emission factors from the United States Environment Protection Agency's GHG emission factors Hub, as shown in reference Table 9 (April 2022) [60]. The emission factors from this reference data include the actual emission from the management pathway as well as the transport of the waste. Table 4.13 shows the data for emission factors of CCB for different waste management methods.

Table 4.13 Emission factors for CCB w.r.t waste management method.

	Emission Factor in Metric Tons CO_2-eq/Short Ton Material		
Material	**Recycled**	**Landfilled**	**Combusted**
Corrugated Container	0.11	0.90	0.05

Carbon emission from EoL phase = Weight of CCB (kg) × percentage of management pathway × emission factor for respective management pathway (kgCO2-eq/kg).

Carbon emission from EoL phase = (1 × 0.81 × 0.12125) + (1 × 0.04 × 0.05511) + (1 × 0.15 × 0.9920).

Carbon emission from EoL phase = 0.2492 kgCO2-eq.

4.3.5 Carbon for the Newly Proposed "Reuse" Phase

The "Reuse" phase proposes collecting used corrugated boxes similar to trash/recycling waste and then checking for usability and reselling the box to be reused. The proposed phase is imagined as a truck driving toward the individual's location to collect old CCB as well as to collect trash. To calculate the carbon emission in the transportation of CCB from a general person's location to a local collection point to reuse the CCB, it is important to identify the average distance the collection truck would travel. The United States Environment Protection Agency's Waste Transfer Stations, a manual for decision making reports, was used [61]. The report refers to the break-even point between the hauling cost and round-trip distance. The break-even point is 35 miles round trip from the waste source to the disposal. Thus, the transportation for this "reuse" phase is assumed to be 35 miles round trip. For emission factors, the United States Environment Protection Agency's GHG emission factors Hub (April 2022) was used and is shown in reference Table 8 [60].

Carbon emission from "Reuse" phase = Weight of waste (kg) × Distance of travel (mile) × Emission factor (kgCO2-eq/kg-mile)

Carbon emission from the “Reuse” phase = 1 × 35 × 0.00023

Carbon emission from the “Reuse” phase = 0.00805 kgCO2-eq

Thus, the carbon emission for each phase of the lifecycle is given in Table 4.14

Table 4.14 Overall carbon emission of CCB over its lifecycle with all the phases.

Emission Type	**Pulp-Making Operation**	**Converting Operation**	**Use Phase**	**Reuse Phase**	**EoL Phase**
Fossil $kgCO_2$-eq	2.17163	0.65744	1.3785	0.00805	0.2492
Biogenic $KgCO_2$-eq (GWP 20 years)	1.33393	-	-	-	-
Biogenic $KgCO_2$-eq (GWP 100 years)	1.26464	-	-	-	-

Thus, below are the overall results:

- The carbon emission of a CCB over its lifecycle (excluding the Reuse phase) is 4.45677 kgCO2-eq for single use;
- The carbon emission of a CCB reused once (including the Reuse phase once and Use phase twice) is 5.84332 kgCO2-eq, i.e., 2.92166 kgCO2-eq per use;
- The carbon emission saved by the “reuse” cycle for every use would be 4.45677 − 2.92166 = 1.53511 kgCO2-eq per use.

In order to show relative comparisons among multiple studies, Table 4.15 compares these results with the previous literature conducted on carbon emissions from CCBs.

Table 4.15 Comparison of carbon emission with the other literature.

Source	Carbon Emission ($kgCO_2$-eq)	Functional Unit (kg)	Carbon Emission per kg of CCB ($kgCO_2$-eq/kg)
[62]	9.9	4	2.475
[63]	3.046	1	3.046
[64]	0.876	0.546	1.60
This chapter	4.4567	1	4.4567

4.3.6 Economic Modeling: Benefit-Cost Analysis

The functional unit considered in this research is 1 kg of CCB. Thus, a CCB of 18 3/8 × 18 3/8 × 18 5/8" (±1/8") dimension is considered. The mass of this particular CCB is 1.01 kg. This particular CCB is currently (December 2022) sold at $2.83 [65]. It is assumed that the cost of a new CCB ($2.83) includes the cost of manufacturing, transportation, and profits (i.e., there is no net external subsidization). The cost of motivation for reuse with a "Positive Reinforced Ethos" incentive is $1.80, as mentioned in previous chapter. Also, it is important to assume and evaluate the cost of reselling CCB. The selling price of a used box to resell is assumed to be $2. Another assumption made for this calculation is that the benefit-cost analysis is carried out for a total of 100,000 boxes. This means we assume there is a need to use 100,000 boxes. Now in this scenario, it can be the use of 100,000 new CCBs or 50,000 boxes which are reused once in their lifecycle as proposed. To perform a benefit-cost analysis, it is important to identify benefits and costs for the newly proposed "reuse" phase.

Benefits:

- Social cost: It is also important to evaluate the social cost of carbon emissions to use in economic modeling. According to Ref. [66], the social cost of carbon could be $900/tCO2, i.e., $ 0.9/kgCO2;

- Cost saving for second use: This is the cost that is saved by using a used box instead of a new box. Basically, it is the cost of production, transportation, and profit of the new box that is saved. In other words, the number of reused boxes is multiplied by the cost of the new box ($1.83). This is beneficial as the “reuse” cycle saves the cost of manufacturing and operating costs.

Cost:

- Cost of motivation: This is the cost that is needed to motivate the general population to assign their CCBs to the “reuse” cycle. This cost is $1.80 per box;
- Cost of reselling the CCBs: This is the cost that individuals pay to buy the reused boxes. This cost includes the operation cost plus the profit for the entity that would coordinate the whole “reuse” cycle.

Thus, the benefits-cost analysis is shown in Table 4.16.

Table 4.16 Benefit-cost analysis for CCB.

Base costs	New box	$2.83
	Used box	$2.00
	Cost for motivation	$1.80
Benefit	Social cost (1.5351 × 0.9 × 100,000 × 1.01)	$131,603.27
	The cost saved by reusing (2.83 × 50,000)	$141,500.00
	Total benefit	$273,103.27
Cost	Motivation cost (1.80 × 50,000)	$90,000.00
	Resell used boxes (operating costs plus profits) (2 × 50,000)	$100,000.00
	Total cost	$190,000.00
	Net Benefit (Total benefit − Total cost)	$83,103.27
	Benefit-Cost ratio (Total benefit/Total cost)	$1.44

4.3.6.1 Sensitivity Analysis

Case I: Lowest cost of a new box ($1.17) for the "reuse" cycle to be profitable as shown in Table 4.17.

Table 4.17 Benefit-cost analysis with the lowest cost of a new box.

Base costs	New box	$1.17
	Used box	$2.00
	Cost for motivation	$1.80
Benefit	Social cost (1.5351 × 0.9 × 100,000 × 1.01)	$131,603.27
	The cost saved by reusing (1.17 × 50,000)	$58,500.00
	Total benefit	$190,103.27
Cost	Motivation cost (1.80 × 50,000)	$90,000.00
	Resell used boxes (operating costs plus profits) (2 × 50,000)	$100,000.00
	Total cost	$190,000.00
	Net Benefit (Total benefit − Total cost)	$103.27
	Benefit-Cost ratio (Total benefit/Total cost)	1.00

Case II: The highest cost of a used box ($3.66) for the "reuse" cycle to be profitable as shown in Table 4.18.

Table 4.18 Benefit-cost analysis with the highest cost of a used box.

Base costs	New box	$2.83
	Used box	$3.66
	Cost for motivation	$1.80
Benefit	Social cost (1.5351 × 0.9 × 100,000 × 1.01)	$131,603.27
	The cost saved by reusing (2.83 × 50,000)	$141,500.00
	Total benefit	$273,103.27
Cost	Motivation cost (1.80 × 50,000)	$90,000.00
	Resell used boxes (operating costs plus profits) (3.66 × 50,000)	$183,000.00
	Total cost	$273,000.00
	Net Benefit (Total benefit − Total cost)	$103.27
	Benefit-Cost ratio (Total benefit/Total cost)	1.00

Case III: Highest cost for motivation ($3.46) for the "reuse" cycle to be profitable as shown in Table 4.19.

Table 4.19 Benefit-cost analysis with the highest cost for motivation.

Base costs	New box	$2.83
	Used box	$2.00
	Cost for motivation	$3.46
Benefit	Social cost (1.5351 × 0.9 × 100,000 × 1.01)	$131,603.27
	The cost saved by reusing (2.83 × 50,000)	$141,500.00
	Total benefit	$273,103.27
Cost	Motivation cost (3.46 × 50,000)	$173,000.00
	Resell used boxes (operating costs plus profits) (2 × 50,000)	$100,000.00
	Total cost	$273,000.00
	Net Benefit (Total benefit − Total cost)	$103.27
	Benefit-Cost ratio (Total benefit/Total cost)	1.00

4.3.7 Economic Modeling: Marginal Cost–Willingness-to-Pay Curves

Willingness-to-pay (WTP) for a new CCB is evaluated by considering eight CCBs with different dimensions and thicknesses as shown in Table 4.20. The reference data is used from "Uline" company's catalog. It is made sure that the mean weight of all eight CCBs is equal to 1 kg.

Table 4.20 Willingness-to-pay for a new CCB.

		Price per Box ($)				
Dimension of CCB	**Weight (kg)**	**25**	**100**	**250**	**500**	**1000**
20 × 18 × 16″ [67]	0.98	4.26	3.97	3.73	3.52	3.27
20 × 16 × 20″ [68]	1.01	4.25	4.04	3.8	3.71	3.43
20 × 12 × 12″ [69]	0.98	4.83	4.39	3.97	3.64	3.38
19 × 19 × 19″ [70]	0.95	4.36	3.97	3.86	3.52	3.29
18 × 18 × 8″ [71]	1.09	5.52	5.16	4.79	4.49	4.3
18 × 18 × 12″ [72]	0.94	2.45	2.45	2.45	2.45	2.45
18 × 18 × 18″ [65]	1.01	2.83	2.83	2.83	2.83	2.83
20 × 18 × 18″ [73]	1.07	4.42	4.15	3.91	3.72	3.39
Average	1.00	4.115	3.87	3.6675	3.485	3.2925

Although WTP for old CCBs is not available, we assumed that the WTP curve for old CCBs would be proportionate to that of the WTP curve of new CCBs. Thus, the slope of the WTP curve for the new CCBs was calculated. In order to draw the WTP curve for old CCBs, the mean of all the prices from Table 4.20 (i.e., $3.686) is taken and is assumed to be proportionate to $2, which is the assumed cost for old CCBs. Thus, that is how values of cost for different numbers of old CCBs are evaluated, as shown in Table 4.21.

Table 4.21 Willingness-to-pay for old CCB.

		Price per Box ($)				
	Weight (kg)	**25**	**100**	**250**	**500**	**1000**
Old CCBs	1.00	2.23	2.10	1.99	1.89	1.79

The marginal cost curves are evaluated from the database collected for survey #1 & #2. In this survey, we asked 13 quantitative questions related to incentives with the help of specific persuasion techniques. Thus, a mean of 13 quantitative questions was taken for each of the 92 participants and categorized them with respect to persuasion techniques. Therefore, there are four marginal cost curves for aesthetics, ethos, logos, and pathos. To plot the WTP and marginal curves, the number of boxes (x-axis) is normalized from 0 to 1. The marginal cost curves show the relation of money to acquire more boxes via the “reuse” cycle. The willingness to pass curve shows the relation of money to consumers buying the number of boxes. Thus, Figure 4.3 below shows WTP and marginal cost curves for CCB.

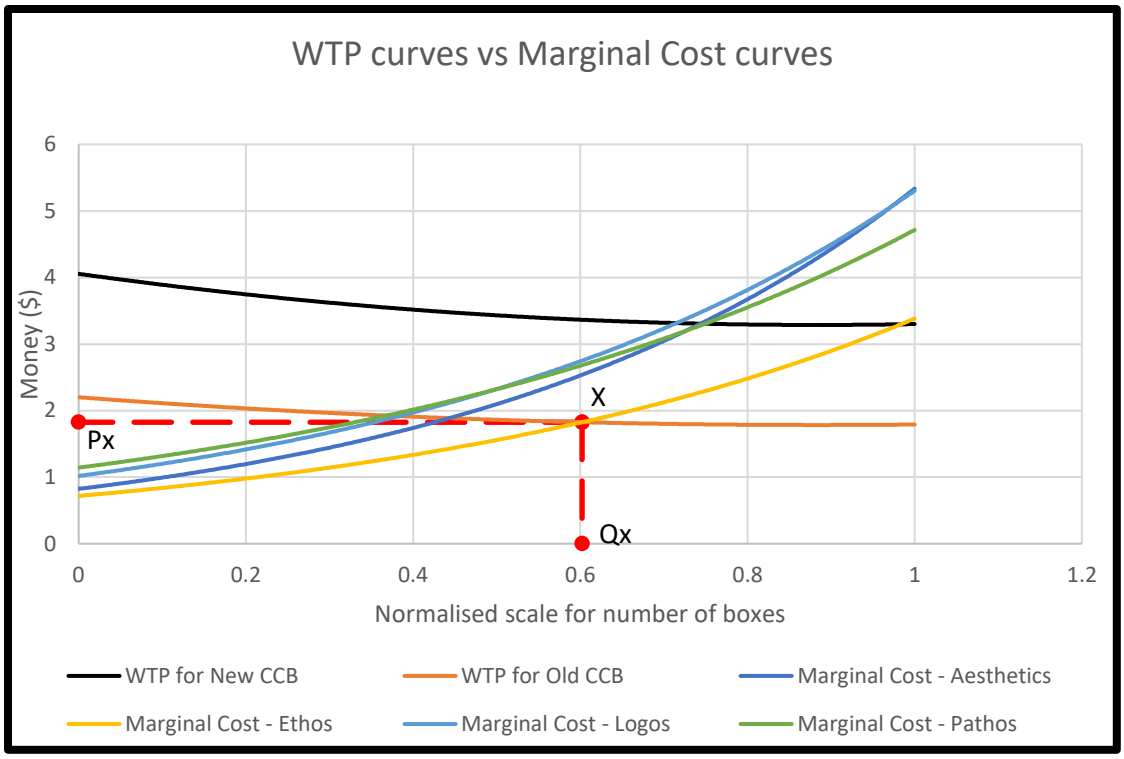


Figure 4.3 Cost curves: WTP curve vs. Marginal cost curve.

4.4 Discussion

OpenLCA software is a tool that uses different databases to get the baseline values and properties of the materials and processes. Thus, multiple databases listed under Table 4.8 were combined to get more precise and specific data to model the CCB lifecycle. Once the model is complete, emission analysis is carried out with a custom impact method, as explained in the methodology section. There are two types of carbon emissions: fossil and biogenic carbon emissions. The only difference between both is their source of carbon emissions. For fossil carbon emission, the source is fossil fuels, and it exposes carbon to the atmosphere, which was trapped in geological reserves for many years. On the other hand, biogenic carbon emission is from woody biomass. The carbon emission from biomass is not trapped for a long time, as the carbon is absorbed from the atmosphere by the biomass. For this research, we considered overall carbon emissions (excluding biogenic CO2 emission). Thus, the results from OpenLCA software consist of the production of CCB ignoring the transportation of the material. As explained in the introduction, pulp

making operations use more energy and have more steps in order to convert the raw material into a paper sheet which explains the high carbon emission in pulp-making operations compared to converting operations. In terms of the transportation of materials and products in pulp-making operations and converting operations, the carbon emission in the converting phase is more than that of the pulp-making operation. One of the main reasons for this is the transportation of containerboard and corrugated sheet to the converting operations, as these are mainly done with the help of trucks. In addition, the transportation of corrugated products to use phase uses trucks as a primary mode of transportation which further adds to carbon emissions. The carbon emission in the use phase is the second highest contributor to the carbon emission of CCB over its lifecycle. One of the main reasons for the high carbon emission in the use phase is the transportation of packages by air. The transportation of CCB by air alone contributes to 93.7% of total carbon emissions in the use phase. From the EoL phase, it is important to notice that the emission factor for recycling waste is more than from the combustion of waste. Thus, 59.7% of the carbon emission in the EoL phase is due to landfilling of CCBs, and 39.4% is due to the recycling of CCBs. The carbon emission of the reuse phase is just 0.18% of all the other phases combined (the current CCB lifecycle). Thus, the current CCB lifecycle carbon emission is 4.46 kgCO2-eq (single-use CCB). Although the carbon emission from CCB is higher compared to the other literature, as shown in Table 4.15, it is important to note that the carbon emission values heavily depend upon the scope and assumptions of the LCA process. Another reason for higher carbon emissions could be because the authors have tried to be more compressive/exhaustive about all the possible carbon sources compared to other papers. The carbon emission for a reused box (used once and reused once) is 2.92 kgCO2-eq per use. Thus overall, the reused CCB would save 1.54 kgCO2-eq for the second time it is used as well, as it will save on the efforts of producing a new CCB.

The overall result from the benefit-cost analysis shows that for the assumed 100,000 uses of a CCB, the 50,000 reused CCBs would give a net profit of $83,103 with a benefit-cost ratio of 1.44. Although

the benefit-cost analysis depends on the assumption made with respect to the operating cost of reuse and resell value of the reused box, sensitivity analysis is carried out to test the boundaries of this business model. The business can break even without making a profit if the cost of the new box is lowered to $1.17, if the reused box is sold at its maximum price of $3.66, or if the cost for motivation is increased to its highest limit of $3.46. Going above the limit specified will adversely affect the profitability of the reuse cycle. The marginal cost and WTP curves give a brief idea of the supply and demand of the CCBs. It can be observed from the graph that the marginal cost of ethos is significantly less than that of the marginal costs of aesthetics, logos, and pathos. Thus, motivating the general population with ethos will have more individuals participating in the reuse cycle at a lower cost. The WTP of the new CCB is included for reference, but the main output of the graph is the intersection point between the WTP of the old CCB and the marginal curves. The point of intersection between the marginal cost curve and the WTP curve is the economic efficiency point. The point of intersection "X" is where the cost of motivation for the used CCB is just exactly equal to the marginal value of the CCB. Thus, the quantity "Qx (0.6022)" at value 'Px ($1.825)' is efficient because it produces a balance between the marginal worth of CCB and what it costs to motivate the general population as measured in the marginal cost curve.

4.5 Conclusions

The purpose of this study was to introduce a new sustainable, feasible way of handling the disposal of CCBs. This chapter calculates the carbon emission of CCBs for their current lifecycle, which is 4.46 kgCO2-eq. The chapter also explains the proposed "reuse" phase, which allows individuals to use a single CCB multiple times. If the CCB is reused once, then it consists of two use phases which means the overall carbon emission for each use drops from 4.46 kgCO2-eq to 2.92 kgCO2-eq. This significantly decreases carbon emissions of CO2 by approximately 34.44%. Thus, by conducting a life cycle analysis, it can be concluded that "reuse" is more sustainable compared to recycling in terms of environmental gains.

It was observed that in terms of economic analysis, the benefit-cost analysis gave a benefit-cost ratio of 1.44 for base assumptions. The sensitivity analysis gave a brief idea of the boundary conditions for this model to keep the benefit-cost ratio above or equal to one. Marginal cost versus willingness-to-pay curves indicated that out of the four available persuasion techniques, the use of ethos for incentivization yielded more boxes to be reused at the lowest cost. This further supports the recommendation of a previous chapter to use ethos to motivate the general population. Thus, it can be concluded from the benefit-cost analysis and cost curves that "reuse" is more sustainable compared to recycling in terms of economic feasibility. The approach that authors took in this research chapter—simultaneously including analytics, WTP and marginal cost curves, and LCA—suggests a model repurposable for use in other products and processes where one can incentivize the general population to take pressure off of the extraction industry as a part of the business. This will allow businesses to take out or lower the extraction needs from similar industries, which would promote sustainable efforts.

The future scope and prospects of this research include how to assess other sustainable efforts for their feasibility across the whole lifecycle and how to evaluate the monetary aspect of the sustainable effort with the help of economics. Although it is well-known that CCBs can be used multiple times in an industrial setting [42,43], it is also important to explore the feasibility and practicality of the implementation of the proposed reuse process. There is a strong possibility of the use of this framework to evaluate other sustainable efforts, such as promoting the use of sustainable cars.

5 SURVEY #3

5.1 Introduction

The United States Environmental Protection Agency defines sustainability as “everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations” [74]. Thus, promoting sustainability efforts is important as humans are directly or indirectly dependent on the environment. According to the United Nations Climate Action [75], the largest contributor to global climate change is the use of fossil fuels and carbon emissions from that. The seven causes identified by the United Nations Climate Action are – generating power, manufacturing goods, cutting down forests, using transportation, producing food, powering buildings, and overconsumption. Thus, this research tries to reduce carbon emissions from five (apart from producing food and overconsumption) of the seven categories mentioned in the case of CCBs. Thus, promoting sustainable efforts is important, which is why this chapter focuses on studying the incentives techniques and recommendations from the previous chapter in depth. Chapter 3 concludes that in terms of motivating the general population for sustainable efforts, segmenting the general population into groups and incenting each group according to their preference is ineffective. Thus, it proposes to incentivize the general population with a generic method. In order to effectively motivate the general population for sustainable efforts, it is important to evaluate this claim of segmentation by additional segmenting options. While conducting surveys, it is a common practice among researchers to collect demographic data and analyze the overall data based on the subcategories. In this chapter, we explore additions segmenting options based on demographic data like age, gender, awareness of environment/climate change, and based on current recycling efforts.

One of the causes mentioned by the UN for climate change is transportation. It is important in terms of the lifecycle of CCB to evaluate the transportation option for the proposed reuse phase. Thus, it is worth exploring the options in the collection of CCBs for the reuse phase. One approach is to have the general population assign the used CCBs to a specific bin called the "reuse" bin. These CCBs will then be collected by a truck and transported to a specific location for further processing. The other option would be that individuals gather their used CCBs and drive to the nearest specific location (collection site) by themselves to drop them off. The two options explored are very different and require different levels of motivation and carbon emissions. As more effort is required for individuals to drive to the collection site, they would need to be motivated more compared to the other option of assigning the CCBs to the reuse bins. The carbon emissions vary in both options, as the option where individuals would need to drive to the collection site would have more carbon emissions as more vehicles will be used which results in more carbon emissions. Thus, this chapter tests the hypothesis that segmenting the general population based on age, gender, recycling efforts, and awareness about environment/climate change would have a significant impact on their preference over incentives.

5.2 Materials and Methods

Chapter 3 concludes that motivating the general population by segmenting them into different groups did not add significant value In order to further examine this in-depth for proving an efficient incentive methodology for carrying sustainable efforts from the general population, another survey was carried out. In order to carry out the surveys (survey #1, #2, & #3), survey questions and methodology were reviewed and approved by Colorado State University's Institutional Review Board (IRB). We received approval following both protocols – protocol number 1932 for surveys #1 & #2 and protocol number 3265 for survey #3. The methodology used in this chapter is similar to chapter 3 as we conducted survey #3 and analyzed data to test their hypothesis. Chapter 3 also uses entropy calculations to determine the quality/clarity of questions with respect to participants' responses. It is important to test the hypothesis

behind the use of entropy as a unit of measure to evaluate the clarity of questions. The authors found a few questions from survey #1 which can be categorized as confusing or double barrels questions. These questions could have been confusing to the participants, which was proven by entropy values. Thus, rephrasing the questions for clarity and evaluating entropy change would prove that entropy gives reliable results.

5.2.1 Survey #3

There were 58 questions in total on this survey. The objective of this survey was to further evaluate and test the results and conclusions from chapter 3 about incentivizing the general population without the necessity of performing market segmentation. This survey evaluates the preferences of the general population with respect to two different ways of collecting processes for the reuse phase (assigning & returning). This survey also evaluates the "entropy" tool used in chapter 3 by rephrasing the question with high entropy. Below are the types of questions that were included in this survey.

1. Six questions to note the demographics of the participants participating in this survey.
2. Questions to evaluate the collection process by assigning CCBs to reuse bins.
    a. Multiple-choice questions (12 questions)
3. Questions to evaluate the collection process by returning CCBs to a specific location.
    a. Multiple-choice questions (12 questions)
4. Questions to assess persuasion preferences.
    a. Likert-type questions (20 questions)
5. Questions to evaluate entropy change by rephrasing.
    a. Likert-type questions (5 questions)

Survey #3 evaluates the possibility of adding value in motivation by segmentation of the general population with respect to demographics. Additionally, it identifies the preferences of the general population over the collection process of CCBs for reusing.

5.3 Results and Analysis

Survey #3 was published online on the social media platform LinkedIn. The survey was also sent to participants from survey #1. Additionally, survey #3 was distributed to students, faculty, and staff of Colorado State University. The survey was created, and the responses were collected online in Qualtrics tool. Survey #3 was active for 50 days and received 151 responses. Qualtrics metadata shows that survey #3 received responses from seven countries. The median time to complete survey #3 was 9.18 minutes.

5.3.1 Results and analysis for Assigning method.

5.3.1.1 Results for multiple choice questions

Multiple choice questions were asked with two options representing two persuasion techniques or two operant conditions each for assigning approach. Thus, the four persuasion techniques (Ethos, Pathos, Logos, and Aesthetics) and four operant conditions (Positive reinforcement, Negative reinforcement, Positive punishment, and Negative punishment) were compared to each other within their respective category. Table 5.1 gives the results for multiple-choice questions for assigning the CCBs.

Table 5.1 Results for multiple choice question on assigning method.

Q.7	Ethos	130
	Pathos	21
Q.8	Ethos	93
	Logos	58
Q.9	Aesthetics	85
	Ethos	66
Q.10	Pathos	76
	Logos	75
Q.11	Aesthetics	121
	Pathos	30
Q.12	Aesthetics	108
	Logos	43

Q.19	Positive Reinforcement	85
	Positive Punishment	66
Q.20	Positive Reinforcement	92
	Negative Punishment	59
Q.21	Negative Reinforcement	85
	Positive Reinforcement	66
Q.22	Positive Punishment	87
	Negative Punishment	64
Q.23	Negative Reinforcement	87
	Positive Punishment	64
Q.24	Negative Reinforcement	109
	Negative Punishment	42

5.3.1.2 Analysis of multiple-choice questions

To analyze the answers for the general population's preference, a Chi-square test was conducted to evaluate if one of the two options was significantly preferred by the participants. As mentioned in Chapter 3, the Chi-square test is used to statistically evaluate the goodness of fit between the expected values and measured values. The total number of participants in Survey #3 was 151; thus, the expected value here is considered to be 75.5. Table 5.2 and 5.3 give the analysis results for assigning the CCBs.

Table 5.2 Chi-square analysis results for persuasion techniques for assigning approach.

Question number	Persuasion technique	Observed score	Expected score	Chi-square score	p-Value
Q.7	Ethos	130	75.5	78.68	<0.00001
	Pathos	21			
Q.8	Ethos	93	75.5	8.113	0.0044
	Logos	58			
Q.9	Aesthetics	85	75.5	2.391	0.12206*
	Ethos	66			
Q.10	Pathos	76	75.5	0.007	0.93514*
	Logos	75			
Q.11	Aesthetics	121	75.5	54.841	<0.00001
	Pathos	30			
Q.12	Aesthetics	108	75.5	27.98	<0.00001
	Logos	43			

In Table 5.2, an asterisk (*) indicates that the results are statistically insignificant at $p \leq 0.01$.

Table 5.3 Chi-square analysis results for operant conditioning for assigning approach.

Question number	Operant condition	Observed score	Expected score	Chi-square score	p-Value
Q.19	Positive Reinforcement	85	75.5	2.391	0.12206*
	Positive Punishment	66			
Q.20	Positive Reinforcement	92	75.5	7.212	0.00725
	Negative Punishment	59			
Q.21	Negative Reinforcement	85	75.5	2.391	0.12206*
	Positive Reinforcement	66			
Q.22	Positive Punishment	87	75.5	3.503	0.06125*
	Negative Punishment	64			
Q.23	Negative Reinforcement	87	75.5	3.503	0.06125*
	Positive Punishment	64			
Q.24	Negative Reinforcement	109	75.5	29.728	<0.00001
	Negative Punishment	42			

In Table 5.3, an asterisk (*) indicates that the results are statistically insignificant at $p \leq 0.01$

5.3.2 Results and analysis for Returning method.

5.3.2.1 Results for multiple choice questions

Multiple choice questions were asked with two options representing two persuasion techniques or two operant conditions each for returning approach. Thus, the four persuasion techniques and four operant conditions were compared to each other within their respective categories. Table 5.4 gives the results for multiple choice questions for returning the CCBs.

Table 5.4 Results for multiple choice question on returning method.

Q.13	Ethos	129
	Pathos	22
Q.14	Ethos	81
	Logos	70
Q.15	Aesthetics	82
	Ethos	69
Q.16	Logos	86
	Pathos	65
Q.17	Aesthetics	123
	Pathos	28
Q.18	Aesthetics	90
	Logos	61

Q.25	Positive Reinforcement	93
	Positive Punishment	58
Q.26	Positive Reinforcement	105
	Negative Punishment	46
Q.27	Positive Reinforcement	79
	Negative Reinforcement	72
Q.28	Positive Punishment	86
	Negative Punishment	65
Q.29	Negative Reinforcement	82
	Positive Punishment	69
Q.30	Negative Reinforcement	105
	Negative Punishment	46

5.3.2.2 Analysis for multiple choice questions

A chi-square test is again conducted to evaluate if one of the two options was significantly preferred by the participants. The expected value here is considered to be 75.5 as mentioned earlier. Table 5.5 and 5.6 give the analysis results for returning the CCBs.

Table 5.5 Chi-square analysis results for persuasion techniques for returning approach.

Question number	Persuasion technique	Observed score	Expected score	Chi-square score	p-Value
Q.13	Ethos	129	75.5	75.821	<0.00001
	Pathos	22			
Q.14	Ethos	81	75.5	0.801	0.3707*
	Logos	70			
Q.15	Aesthetics	82	75.5	1.119	0.29009*
	Ethos	69			
Q.16	Logos	86	75.5	2.921	0.08746*
	Pathos	65			
Q.17	Aesthetics	123	75.5	59.768	<0.00001
	Pathos	28			
Q.18	Aesthetics	90	75.5	5.57	0.01828*
	Logos	61			

In Table 5.5, an asterisk (*) indicates that the results are statistically insignificant at $p \leq 0.01$.

Table 5.6 Chi-square analysis results for operant conditioning for assigning approach.

Question number	Operant condition	Observed score	Expected score	Chi-square score	p-Value
Q.25	Positive Reinforcement	93	75.5	8.113	0.0044
	Positive Punishment	58			
Q.26	Positive Reinforcement	105	75.5	23.053	<0.00001
	Negative Punishment	46			
Q.27	Positive Reinforcement	79	75.5	0.325	0.5689*
	Negative Reinforcement	72			
Q.28	Positive Punishment	86	75.5	2.921	0.08746*
	Negative Punishment	65			
Q.29	Negative Reinforcement	82	75.5	1.119	0.29009*
	Positive Punishment	69			
Q.30	Negative Reinforcement	105	75.5	23.053	<0.00001
	Negative Punishment	46			

In Table 5.6, an asterisk (*) indicates that the results are statistically insignificant at $p \leq 0.01$

5.3.3 Results and analysis for Likert-scale questions

5.3.3.1 Results for Likert scale questions

Likert scale questions were asked to evaluate the general population's preferences over persuasion techniques. Likert scale questions include five options as follows: strongly agree, somewhat

agree, neither agree nor disagree, somewhat disagree, and strongly disagree. To evaluate the results based on the responses, a linear scoring scale was considered with strongly disagree as 1 and strongly agree as 5. Table 5.7 gives the results for the Likert scale questions.

Table 5.7 Results for Likert scale questions

Persuasion technique	Question number	Score	Mean score
Aesthetics	Q35	4.37	4.28
	Q40	4.31	
	Q45	4.32	
	Q50	4.28	
	Q54	4.13	
Ethos	Q32	4.19	4.21
	Q36	4.25	
	Q41	4.28	
	Q46	4.07	
	Q51	4.26	
Logos	Q34	4.06	3.46
	Q39	4.06	
	Q44	3.80	
	Q48	2.21	
	Q53	3.15	
Pathos	Q33	3.56	3.98
	Q38	4.04	
	Q42	3.99	
	Q47	4.05	
	Q52	4.28	

5.3.3.2 Analysis of Likert scale questions

To analyze the data from Likert scale questions, an independent t-test was calculated to compare each pair of persuasion technique scores. Table 5.8 gives the results of the independent t-tests on the Likert scale questions.

Table 5.8 Independent t-test results.

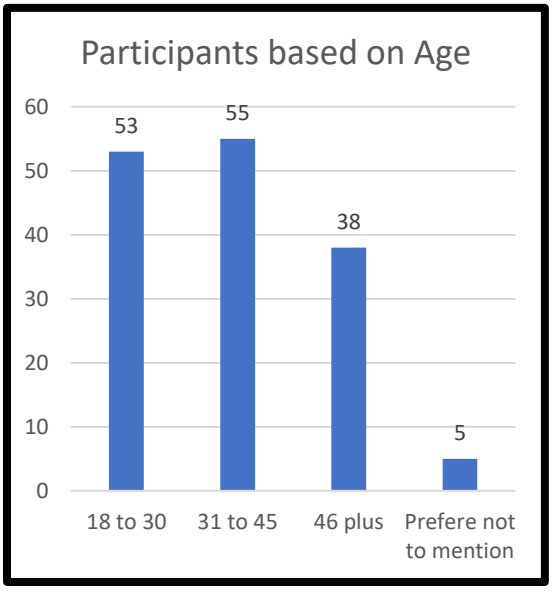
Comparison of persuasion techniques	*t*-value	*p*-value
Ethos (4.21) with Pathos (3.98)	2.25	0.024
Ethos (4.21) with Logos (3.46)	2.59	0.013
Aesthetics (4.28) with Ethos (4.21)	1.57	0.073*
Aesthetics (4.28) with Pathos (3.98)	2.94	0.007
Aesthetics (4.28) with Logos (3.46)	2.84	0.008
Logos (3.46) with Pathos (3.98)	1.61	0.069*

In Table 5.8, an asterisk (*) indicates that the results are statistically insignificant at $p \leq 0.05$

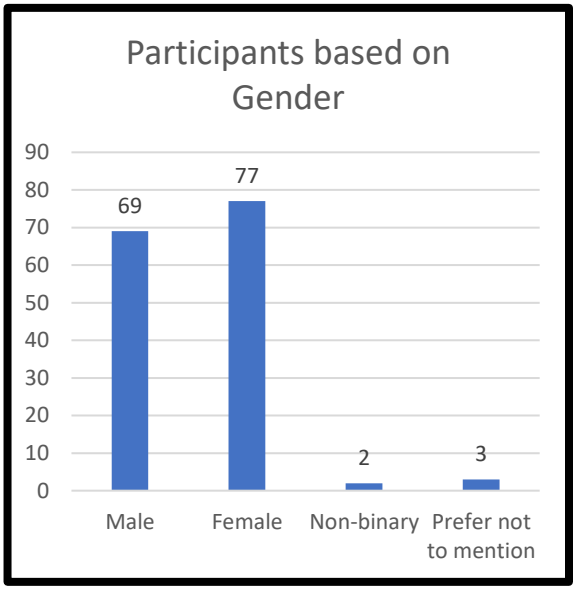
5.3.4 Results and analysis of data based on demographics.

5.3.4.1 Results based on demographics.

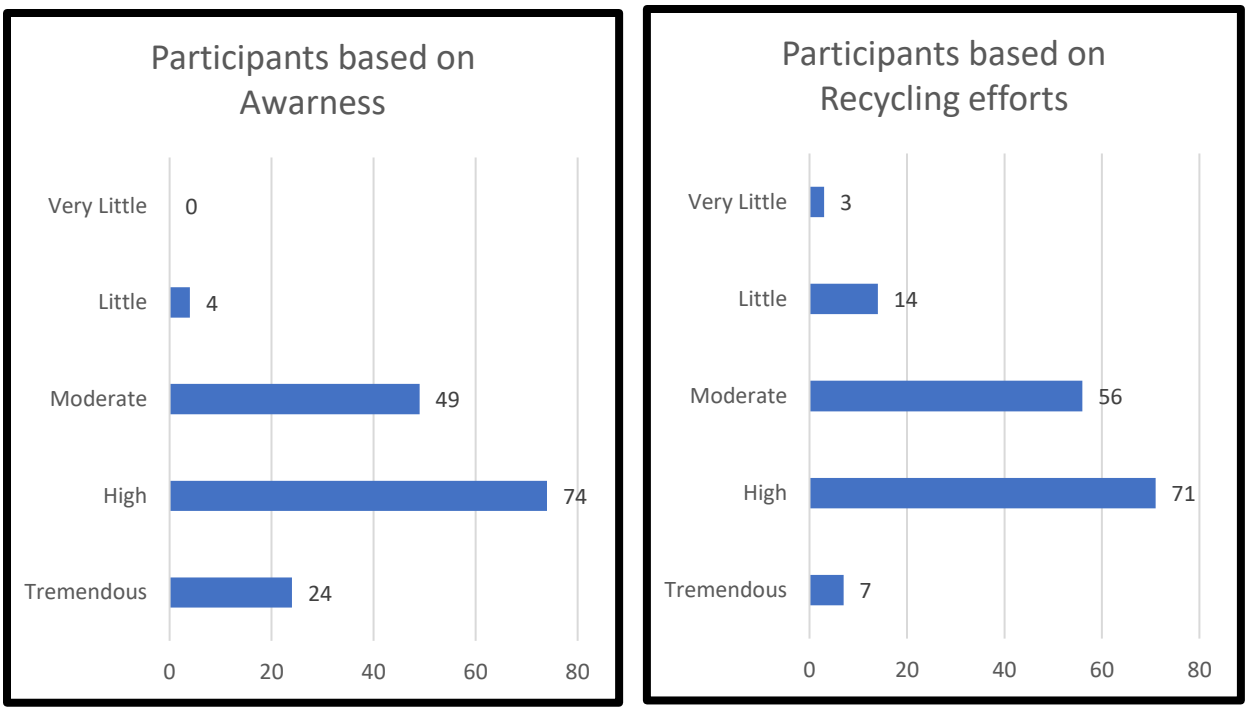
In total, six demographic questions were asked. These questions help to identify participant's age, gender, awareness of climate change, and their current recycling efforts. Figure 5.1 shows the results of the distribution of participants based on the respective demographic information.



(a)



(b)



(c) (d)

Figure 5.1 Results for participant's demographics based on (a) age, (b) gender, (c) awareness, and (d) recycling efforts.

5.3.4.2 Analysis of data based on demographics.

The data is partitioned by demographic groups and analyzed based on the question types. Multiple choice questions were analyzed by conducting a chi-square test, whereas t-tests were employed to evaluate data from Likert scale questions. The results of data analyzed based on demographics are given in Appendix A.

5.3.5 Results and analysis for entropy calculations.

5.3.5.1 Results for entropy calculation questions.

In total, five questions were asked in Survey #3 to examine the entropy change. These questions (originally from Survey #1) were reworded for clarity. Table 5.9 shows the answers for five Likert scale questions from Survey #3 (reworded originally from Survey #1).

Table 5.9 Results for Likert scale question for entropy calculation

Survey #1 reference question number	Survey #3 question number	Score
Q13	Q55	3.66
Q14	Q56	4.54
Q17	Q57	3.60
Q27	Q58	3.46
Q32	Q59	4.14

5.3.5.2 Analysis for entropy calculations.

Definition of entropy and method to calculate entropy is provided in Chapter 2. Similarly, the entropy is calculated for the questions from Survey #3. Entropy values from Survey #1 that are specified in chapter 2 are taken and the differences between the two values are calculated as shown in Table 5.10.

Table 5.10 Entropy calculations for reworded questions.

Survey #1 reference question number	Entropy values from survey #1	Survey #3 question number	Entropy values from survey #3	Entropy difference	Entropy difference in %
Q13	2.11	Q55	2.10	0.01	0.47%
Q14	1.92	Q56	1.30	0.62	32.29%
Q17	2.03	Q57	2.11	-0.08	-3.94%
Q27	2.21	Q58	2.11	0.10	4.52%
Q32	2.16	Q59	1.74	0.42	19.44%

5.4 Discussion

In total, 24 multiple-choice questions were asked on Survey #3. As these multiple-choice questions had two options comparing each other, a Chi-square test was carried out to evaluate the participant's preference. Thus, four options compared to each other would lead to six pairs in total. Table 5.1 and Table 5.4 give the preference results for assigning the CCBs to reuse bin and returning the CCBs to specific locations, respectively. For assigning the CCBs with respect to persuasion techniques, it can be observed from Table 5.2 that the general population significantly responds more willingly ethos and

aesthetics over logos and pathos. The difference between ethos and aesthetics is not statistically significant, and the difference between pathos and logos is also not statistically significant. For assigning the CCBs with respect to operant conditions, it can be observed from Table 5.3 that positive reinforcement is statistically significantly preferred over negative punishment, and negative reinforcement is statistically significantly preferred over negative punishment. The other four comparisons of operant conditions to each other are not statistically significantly different. For returning the CCBs with respect to persuasion techniques, it can be observed from Table 5.5 that the general population statistically significantly prefers ethos over pathos and aesthetics over pathos. The difference between logos and both aesthetics and pathos is not statistically significant, whereas the difference between ethos to logos and aesthetics is not statistically significant. For returning the CCBs with respect to operant conditions, it can be observed from Table 5.6 that positive reinforcement is statistically significantly preferred over both negative punishment and positive punishment. Also, negative reinforcement is statistically significantly preferred over negative punishment. The difference between positive punishment with both negative punishment and negative reinforcement is not statistically significant. Whereas the difference between positive punishment and negative reinforcement is not statistically significant. Table 5.7 shows the results for Likert scale questions that evaluate the persuasion preferences of participants. The questions are scored on a scale of 1 to 5, where 1 is strongly disagree (not preferred) and 5 is strongly agree (preferred). Aesthetics scored highest followed by ethos with a small margin (0.07), followed by pathos, followed by logos. The t-value test shows that at $p \leq 0.05$, ethos and aesthetics are statistically significantly different compared to pathos and logos. It also shows that the difference between ethos and aesthetics as well as logos and pathos is not statistically significant.

This chapter mainly evaluates if segmenting the general population based on their demographic information would be an effective approach for motivating the general population to adopt desired sustainable efforts. Based on the age of participants, the results of chi-square test is given in Table A.1.

The results for assigning and returning the CCBs for the age 18 to 30 group show that participants prefer ethos, logos, and aesthetics over pathos. Among ethos, logos, and aesthetics, the preference is unclear for assigning or returning CCBs. In the case of operant conditions, the age group of 18 to 30 never statistically significantly preferred negative punishment for assigning nor for returning the CCBs. Among positive reinforcement, positive punishment, and negative reinforcement the preference is unclear with respect to assigning or returning the CCBs. In the case of age group of 31 to 45 and 46 plus, pathos and logos were never statistically significantly preferred for assigning or returning CCBs. The preference on ethos and aesthetics is unclear. For the age group of 31 to 45, positive reinforcement and negative reinforcement are statistically significantly preferred over negative punishment for assigning as well as returning of CCBs. For assigning and returning with operant conditions, the age group 46 plus statistically significantly preferred positive reinforcement over positive punishment and negative reinforcement over both negative punishment and positive punishment. For assigning and returning of CCBs the prefer not to mention age group statistically significantly preferred ethos over pathos and negative reinforcement over positive punishment.

Chi-square results for the gender of participants are given in Table A.2. The results show that both male and female participants for assigning the CCBs statistically significantly preferred ethos, aesthetics over pathos and aesthetics over logos. The female participants statistically significantly preferred ethos, logos, and aesthetics over pathos for returning the CCBs. On the other hand, male participants for returning the CCBs statistically significantly preferred aesthetics over logos and both ethos and aesthetics over pathos. For male participants for assigning CCBs, negative reinforcement was statistically significantly preferred over negative punishment. For returning the CCBs, male participants statistically significantly preferred positive reinforcement over positive punishment and negative reinforcement over both positive punishment and negative punishment. In the case of female participants for assigning as well as returning CCBs, positive reinforcement, negative reinforcement, and positive punishment were statistically

significantly preferred over negative punishment. For the gender group of non-binary and prefer not to mention, no statistically significant preference between persuasion techniques and operant conditions were observed for both assigning and returning the CCBs.

Chi-square results for the awareness of participants are given in Table A.3. The preference for assigning the CCBs to the reuse bin for participants with tremendous, high, and moderate awareness was observed similar to other experiments, with a statistically significant preference for ethos over pathos and for aesthetics over both pathos and logos. Preferences of participants with tremendous, high, and moderate awareness were similar in the case of returning the CCBs as they statistically significantly preferred ethos and aesthetics over pathos. For assigning the CCBs, participants with tremendous awareness statistically significantly preferred negative reinforcement over both negative punishment and positive reinforcement. Whereas participants with tremendous awareness for returning the CCBs, statistically significantly preferred negative reinforcement over negative punishment. Negative reinforcement over negative punishment was statistically significantly preferred for assigning the CCBs by participants with high awareness. For returning the CCBs, participants with high awareness statistically significantly preferred negative reinforcement over negative punishment, and positive reinforcement over both negative punishment and positive punishment. The preference on assigning the CCBs by participants with moderate awareness was statistically significantly towards positive reinforcement, positive punishment, and negative reinforcement over negative punishment. Whereas for returning the CCB, the participant with moderate awareness statistically significantly preferred positive reinforcement over negative punishment. For participants with little awareness, no statistically significant preference between persuasion techniques and operant conditions was observed for both assigning and returning the CCBs. The survey did not receive any responses from any participants that identified as having very little awareness of the environment and climate change.

The chi-square test results for recycling efforts of participants are given in Table A.4. For participants with tremendous recycling efforts, no statistically significant preference was found for assigning and returning the CCBs apart from negative reinforcement over negative punishment for assigning the CCBs. For assigning, participants with high and moderate recycling efforts statistically significantly preferred aesthetics over logos, and both aesthetics and ethos over pathos. For returning, participants with high recycling efforts statistically significantly preferred aesthetics over logos, as well as ethos, logos, and aesthetics over pathos. The preference for assigning the CCBs by participants with high recycling efforts was statistically significantly towards negative reinforcement over negative punishment. For returning the CCBs, participants with moderate recycling efforts statistically significantly preferred both aesthetics and ethos over pathos. Both positive punishment and negative reinforcement over negative punishment are statistically significantly preferred for assigning the CCBs by participants with moderate recycling efforts. For returning CCBs, the participants with moderate recycling efforts statistically significantly preferred positive reinforcement, negative reinforcement, and positive punishment over negative punishment. In the case of assigning and returning the CCBs, participants with little recycling efforts statistically significantly preferred ethos over pathos as well as aesthetics over both ethos and pathos. For assigning the CCBs, participants with little recycling efforts statistically significantly preferred positive reinforcement over negative punishment. For participants with very little recycling efforts, no statistically significant preference between persuasion techniques and operant conditions was observed for both assigning and returning the CCBs.

Likert scale questions and analysis of the t-test for varying ages of participants are given in Table A.5 and Table A.6. For the age group of 18 to 30, participants statistically significantly preferred both aesthetics and ethos over pathos. For the age group of 31 to 45, participants statistically significantly preferred ethos over logos as well as aesthetics over both logos and pathos. Participants over the age of 40 statistically significantly responded more readily to ethos over logos persuasion, along with pathos

over logos, as well as aesthetic over ethos, pathos, and logos. Participants under the age group of “prefer not to answer” also statistically significantly preferred aesthetics over pathos. Likert scale questions and analysis of the t-test for varying participant gender are given in Table A.7 and Table A.8. It can be observed that male participants statistically significantly preferred ethos over logos as well as aesthetics over ethos, pathos, and logos. Participants that identified as female and non-binary statistically significantly preferred ethos over both logos and pathos as well as aesthetics over both pathos and logos. For participants under prefer not to mention, no statistically significant preferences were observed.

Likert scale questions and analysis of the t-test for varying awareness of participants are given in Table A.9 and Table A.10. Participants with tremendous awareness statistically significantly preferred pathos over logos, ethos over both logos and pathos, as well as aesthetics over ethos, pathos, and logos. The participants with high and little awareness had similar preferences as they statistically significantly preferred ethos over logos and aesthetics over both pathos and logos. Lastly, participants with moderate awareness statistically significantly preferred aesthetics over both pathos and logos. Likert scale questions and analysis of the t-test for variable participant recycling effort are given in Table A.11 and Table A.12. Participants with tremendous and moderate recycling efforts had similar preferences as they statistically significantly preferred aesthetics over ethos, pathos, and logos. Participants with high recycling efforts statistically significantly preferred ethos over logos as well as aesthetics over both pathos and logos. Participants with little recycling efforts statistically significantly preferred both ethos and aesthetics over pathos. Lastly, participants with very little recycling effort statistically significantly preferred pathos over logos as well as both aesthetics and ethos over logos. Table 5.9 shows the results for entropy calculations as well as gives the reference questions from survey #1 that were reworded. It can be observed from Table 5.10 that entropy decreased for Q55, Q56, Q58, and Q59. Only Q57 had an increase in entropy by 3.94%. Overall, for 5 questions, the entropy decreased by 10.56%.

5.5 Conclusion

The purpose of this chapter was to further examine the results from Chapter 3 regarding segmenting the general population to effectively motivate them for sustainable efforts. From the results and analysis of the multiple choice questions, it can be observed that for assigning the CCBs to the reuse bin, the general population preferred aesthetics and ethos over pathos and logos. This indicates that both ethos and aesthetics persuasion techniques are preferred by the general population for assigning CCBs. In the case of assigning the CCBs with respect to operant conditions, no significant preference was found. In the case of returning the CCBs with the help of persuasion techniques and operant conditions, no significant preference of a single persuasion technique over another or a single operant condition over another was found. In the case of Likert scale questions, the results are similar to that of assigning the CCBs to reuse bins, the general population preferred both ethos and aesthetics over logos and pathos. This implies that both aesthetics and ethos are preferred by the general population to motivate themselves for sustainable efforts. Survey #3 segments the general population based on their gender, age, awareness of environment/climate change, and their current recycling efforts. The authors conducted t-test and chi-square tests on the results and evaluated each sub-category for assigning/ returning the CCBs with respect to persuasion techniques and operant conditions. It can be concluded that no significant trend in the preferences was observed. This chapter also reexamines the use of entropy to evaluate questions for confusion and/or for being double-barreled. The results for the five reworded questions from survey #1 show that overall, the entropy decreased by 10.56%. As these five questions were identified by authors to be confusing and double-barreled in survey #1, they reworded them to make them clearer and more direct. It can be concluded that entropy may be used in some cases to evaluate the clarity/quality of the survey questions.

Overall, it can be concluded that the segmentation of the general population based on demographics does not yield an effective way of incentivizing the general population for sustainable

efforts. Also, to motivate the general population to conduct sustainable efforts, ethos and aesthetics are preferred. This supports the claim from Chapter 3 about not segmenting the general population for motivation as well as using ethos to motivate the general population. In terms of assigning the CCBs to reuse bin and returning the CCBs to a specific location, it can be concluded that assigning the CCBs to the reuse bin is preferred by the general population over returning them, which is considered in the life cycle analysis for reusing the CCBs in Chapter 4.

The future scope and prospects of this study include identifying a way to convey the incentive message as well as exploring different incentive delivering methods. As seen from the entropy calculations, it is important to frame a clear incentive message which would need further research. The use of the entropy concept as a tool to evaluate questionnaires would help future researchers to evaluate their questions and improve them accordingly.

6 GENERAL CONCLUSION

The purpose of this research was to propose a new process that increases sustainability efforts and addresses the underlying problem regarding the current lifecycle of CCBs. Objectives number 1 and 2 of this research were addressed in Chapter 3. The results of Chapter 3 indicate that to incentivize the general population to make certain sustainable efforts, a combined approach of persuasion techniques and operant conditions can be used. Although the chapter explores 12 different types of incentives based on combining persuasion techniques and operant conditions, it concludes that the most effective and cost-efficient incentive is "positive reinforcement + ethos". Here the general population is persuaded by using ethos and to keep the general population in the loop to continue the sustainable effort multiple times, positive reinforcement is used. The cost of positive reinforcement ethos incentive methods is $1.80 for each sustainable effort (reusing CCB in this case). Objective number 3 is addressed in Chapters 3 and 5. Both these chapters provide support for the conclusion that incenting the general population with a generic method would be the most effective way of motivating them instead of segmenting the general population. The research tries to segment the general population by their personality type, persuasion type, operant conditions, age, gender, awareness of environment/climate change, and based on their current recycling efforts. This research also explored two ways of collecting CCBs for reuse based on the general population assigning the CCBs to reuse bins and the general population returning the CCBs to a specific collection location. Chapter 5 results support the interpretation that the general population preferred assigning the CCBs to a reuse bin over returning the CCBs. Objectives number 4 and 5 are addressed in Chapter 4. It goes in-depth with the carbon emission of each phase of CCB. The life cycle analysis conducted on CCB in Chapter 4 supports the interpretation that the current carbon emission of CCBs is 4.46 $kgCO_2$-eq. The chapter also conducts a life cycle analysis of CCB based on the proposed reuse approach. The carbon emission of CCB over its life cycle (used once and reused once) as proposed would

result in a carbon emission of 2.92 kgCO_2-eq. Thus, the carbon emission saved by the reuse cycle for every use is calculated to be 1.53 kgCO_2-eq (34.44% less than current emissions). Chapter 4 also evaluates the economic feasibility of the proposed reuse phase by conducting benefit-cost analysis as well as with willingness-to-pay and marginal cost curves. The chapter concludes that from a financial and environmental standpoint, the proposed reuse approach is economically feasible. This research also concludes that entropy may be used to evaluate the questions from the survey for its clarity.

Overall, this research establishes a framework for a sustainability approach with economics, analytics, and lifecycle analysis as elements to evaluate the scope of improvement in order to save carbon emissions and promote sustainable solutions from a holistic approach. The future scope of this research would be to figure out an effective way to put across the message of the incentive. Delivering the incentive and implementing the reuse method physically would be additional future areas of research. This research could be a basis to evaluate other sustainability efforts by using the proposed framework. Exploring the application of the 16 types of incentives to different sustainable efforts would be important follow on of this dissertation.

REFERENCES

1. Harrod, S, The Future of Corrugated Packaging to 2025; Smithers, Ohio, USA,2020. https://www.smithers.com/resources/2020/sept/corrugated-packaging-to-top-$200-billion-by-2025
2. National Council for Air and Stream Improvement, Inc. (NCASI). 2017. 2014 Life Cycle Assessment of U.S. Average Corrugated Product – Final Report. Report prepared for the Corrugated Product Alliance (CPA). Cary, N.C.: National Council for Air and Stream Improvement., Inc.
3. Glittenberg, D. 10.07 – Starch-Based Biopolymers in Paper, Corrugating, and Other Industrial Applications. Elsevier, 2012,10,165-193. https://doi.org/10.1016/B978-0-444-53349-4.00258-2
4. ABB Group. All of Those Boxes. Available online: https://new.abb.com/docs/librariesprovider15/default-document-library/no5_boxes_oct14.pdf?sfvrsn=2 (accessed on 12 April 2022).
5. Recycling.com. Why Cardboard Recycling Is Crucial to Protect the Earth. Available online: https://www.ocrecycling.com/ cardboard-recycling-crucial (accessed on 12 April 2022).
6. United States Environmental Protection Agency. Facts and Figures about Materials, Waste and Recycling. Available online: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/containers-and-packaging-product-specific# PaperandPaperboardC&P (accessed on 11 April 2022).
7. Weise, E. Blue Bins Overflow with Amazon and Walmart Boxes. But We're Actually Recycling Less. USA TODAY. Available online: https://www.usatoday.com/story/tech/news/2018/06/08/cardboard-recycling-rates-drop-shopping-amazon-walmart-surges/630967002/ (accessed on 11 April 2022).
8. Mouw, S. 2020 State of Curbside Recycling Report; The Recycling Partnership: Falls Church, VA, USA, 2020.

9. Corrugated Packaging Alliance. Corrugated Packaging—A Recycling Success Story; Corrugated Packaging Alliance: Elk Grove Village, IL, USA, 2016.
10. Fibre Box Association. Corrugated Packaging—An Extraordinary Recycling Success Story. Available online: http://www.corrugated.org/wp-content/uploads/2019/12/Recycling_White_Paper_2019_vfinal.pdf (accessed on 11 April 2022).
11. Del Rio, D. D. F.; Sovacool, B. K.; Griffiths, S.; Bazilian, M.; Kim, J.; Foley, A. M.; Rooney, D. Decarbonizing the pulp and paper industry: A critical and systematic review of sociotechnical developments and policy options. Renew. Sustain. Energy. Rev. 2022, 167, 112706. https://doi.org/10.1016/j.rser.2022.112706.
12. United States Environmental Protection Agency. Environmental Issues Terms & Acronyms. Available online: https://sor.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=Environmental%20Issues%20Glossary&filterTerm=pollution&checkedAcronym=true&checkedTerm=true&hasDefinitions=%20true&filterTerm=pollution (accessed on 4 April 2022).
13. Metz, B.; Davidson, O.R.; Bosch, P.R.; Dave, R.; Meyer, L.A. (Eds.) Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2007.
14. United States Environmental Protection Agency. Advancing Sustainable Materials Management: 2018 Fact Sheet; United States Environmental Protection Agency Office of Land and Emergency Management: Washington, DC, USA, 2020.
15. Abila, B. Households' perception of financial incentives in endorsing sustainable waste recycling in Nigeria. Recycling 2018, 3, 1–8, https://doi.org/10.3390/recycling3020028.
16. Gilli, M.; Nicolli, F.; Farinelli, P. Behavioural attitudes towards waste prevention and recycling. Ecol. Econ. 2018, 154, 294–305, https://doi.org/10.1016/j.ecolecon.2018.08.009.

17. Kattoua, M.G.; Al-Khatib, I.A.; Kontogianni, S. Barriers on the propagation of household solid waste recycling practices in developing countries: State of Palestine example. J. Mater. Cycles Waste 2019, 21, 774–785, https://doi.org/10.1007/s10163-019-00833-5.
18. Seacat, J.D.; Boileau, N. Demographic and community-level predictors of recycling behavior: A statewide, assessment. J. Environ. Psychol. 2018, 56, 12–19, https://doi.org/10.1016/j.jenvp.2018.02.004.
19. Li, C.; Wang, Y.; Li, Y.; Huang, Y.; Harder, M.K. The incentives may not be the incentive: A field experiment in recycling of residential food waste. Resour. Conserv. Recycl. 2021, 168, 105316, https://doi.org/10.1016/j.resconrec.2020.105316.
20. Hole, G.; Hole, A.S. Improving recycling of textiles based on lessons from policies for other recyclable materials: A minireview." *Sustain. Prod. Consum.* **2020**, *23*, 42–51, https://doi.org/10.1016/j.spc.2020.04.005.
21. Guay, F.; Chanal, J.; Ratelle, C.F.; Marsh, H.W.; Larose, S.; Boivin, M. Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. Br. J. Educ. Psychol. 2010, 80, 711–735, https://doi.org/10.1348/000709910X499084.
22. Gredler, M.E. Learning and Instruction: Theory into Practice, 4th ed.; Pearson/Merrill Prentice Hall: New Jersey, USA, 2001; ISBN 978-013-012-227-8.
23. Perloff, R.M. The Dynamics of Persuasion: Communication and Attitudes in the Twenty-First Century; Routledge: New York, NY, USA, 2007; ISBN 978-036-718-579-4.
24. O'Keefe, D.J. Persuasion: Theory and Research; Sage Publications: London, UK, 2016; ISBN 978-145-227-667-0.
25. Skinner, B.F. Two types of conditioned reflex: A reply to Konorski and Miller. J. Gen. Psychol. 1937, 16, 272–279, https://doi.org/10.1080/00221309.1937.9917951.

26. Staddon, J.E.; Cerutti, D.T. Operant conditioning. Ann. Rev. Psychol. 2003, 54, 115–144, https://doi.org/10.1146/annurev.psych.54.101601.145124.
27. Gilbert, A.P. A Comparison of the Murry-Meisgeier Type Indicator for Children and the Myers-Briggs Type Indicator. Doctoral Dissertation, The Ohio State University, Columbus, OH, USA, 1990.
28. Jacobson, C.M. Cognitive styles of creativity: Relations of scores on the Kirton Adaption-Innovation Inventory and the Myers-Briggs Type Indicator among managers in USA. Psychol. Rep. 1993, 72 (Suppl. 3), 1131–1138, https://doi.org/10.2466/pr0.1993.72.3c.1131.
29. Brownfield, K.M., "The Relationship between the Myers-Briggs Personality Types and Learning Styles". Available online: https://eric.ed.gov/?id=ED381577 (accessed in 12 April 2022).
30. Celli, F.; Lepri, B. Is Big Five Better than MBTI? A Personality Computing Challenge Using Twitter Data. In the Proceedings of the Fifth Italian conference on Computational Linguistics CLIC-It, Torino, Italy, 10-12 December 2018. https://doi.org/10.4000/books.aaccademia.3147.
31. Bright Side, "The Most Precise 4-Question Personality Test". Available online: https://brightside.me/inspiration-psychology/the-most-precise-4-question-personality-test-392210/ (accessed on 11 April 2022).
32. Natal, J.; Avila, I.; Tsukahara, V.B.; Pinheiro, M.; Maciel, C.D. Entropy: From Thermodynamics to Information Processing. Entropy 2021, 23, 1340, https://doi.org/10.3390/e23101340.
33. Larson, M.G. Analysis of variance. Circulation 2008, 117, 115–121, https://doi.org/10.1161/CIRCULATIONAHA.107.654335.
34. Hamming, R.W. Error detecting and error correcting codes. Bell Syst. Tech. J. 1950, 29, 147–160, https://doi.org/10.1002/j.1538-7305.1950.tb00463.x.
35. Saad, R.; Ahmad, M.Z.; Abu, M.S.; Jusoh, M.S. Hamming distance method with subjective and objective weights for personnel selection. Sci. World J. 2014, 2014, 1–9, https://doi.org/10.1155/2014/865495.

36. 16Personalities, “Free Personality Test”. Available online: https://www.16personalities.com/free-personality-test (accessed on 12 April 2022)
37. Mak, T.M.; Iris, K.M.; Tsang, D.C.; Hsu, S.C.; Poon, C.S. Promoting food waste recycling in the commercial and industrial sector by extending the Theory of Planned Behaviour: A Hong Kong case study. J. Clean. Prod. 2018, 204, 1034–1043, https://doi.org/10.1016/j.jclepro.2018.09.049.
38. Hong, S.; Adams, R.M. Household responses to price incentives for recycling: Some further evidence. Land Econ 1999, 75, 505–514, https://doi.org/10.2307/3147062.
39. Thøgersen, J. Monetary incentives and recycling: Behavioural and psychological reactions to a performance-dependent garbage fee. J. Consum. Policy 2003, 26, 197–228, https://doi.org/10.1023/A:1023633320485.
40. Abila, B.; Kantola, J. The perceived role of financial incentives in promoting waste recycling—Empirical evidence from Finland. Recycling 2019, 4, 4, https://doi.org/10.3390/recycling4010004.
41. Gibovic, D.; Bikfalvi, A. Incentives for Plastic Recycling: How to Engage Citizens in Active Collection. Empirical Evidence from Spain. Recycling 2021, 6, 29, https://doi.org/10.3390/recycling6020029.
42. Box LatchTM Products Featured in London Trade Show- Box Latch Products. Available online: https://www.boxlatch.com/box-latch-products-featured-london-trade-show/ (accessed on 14 May 2022).
43. Box Latch 10+ Box Re-Use| Closed-Loop Production Process | Wisconsin Plastics, Inc. Available online: https://www.youtube.com/watch?v=FkjqiLX39yg (accessed on 14 May 2022).
44. Curran, M. LIFE-CYCLE ASSESSMENT; Encyclopedia of Ecology; Subject Area: Human Ecology; Jorgensen, S.E., Fath, B., Eds.; Elsevier BV: Amsterdam, Netherlands, 2008; Chapter 13, pp. 2168–2174, ISBN 978008045405.
45. United States Census Bureau: CF1700P2|CFS Preliminary Report: Shipment Characteristics by Total Modal Activity: 2017. Available online:

https://data.census.gov/table?q=cf1700p2&hidePreview=true&tid=CFSPRELIM2017.CF1700P2 (accessed on 22 December 2022).

46. U.S. Energy Information Administration: U.S. utility-scale electricity generation by source, amount, and share of total in 2021. Available online: https://www.eia.gov/tools/faqs/faq.php?id=427&t=3#:~:text=In%202021%2C%20about%204%2C108%20billion,facilities%20in%20the%20United%20States.&text=About%2061%25%20of%20this%20electricity,%2C%20petroleum%2C%20and%20other%20gases (accessed on 22 December 2022).
47. Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M., Eds. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2013; p. 1535.
48. Field, B.; Field, M. Environmental Economics An Introduction, 8th ed.; McGraw-Hill: New York, NY, USA, 2021.
49. Carey, K. Cost Function Estimates. In Encyclopedia of Health Economics; Culyer, A., Eds.; Elsevier: Amsterdam, The Netherlands, 2014; pp. 121–125.
50. OpenLca Nexus: AGRIBALYSE. Available online: https://nexus.openlca.org/database/Agribalyse (accessed on 22 December 2022).
51. OpenLca Nexus: BIOENERGIEDAT. Available online: https://nexus.openlca.org/database/bioenergiedat (accessed on 22 December 2022).
52. OpenLca Nexus: Ecoinvent. Available online: https://nexus.openlca.org/database/ecoinvent (accessed on 22 December 2022).
53. OpenLca Nexus: PEF Database. Available online: https://nexus.openlca.org/database/Environmental%20Footprints (accessed on 22 December 2022).

54. OpenLca Nexus: JRC European Commission. Available online: https://nexus.openlca.org/database/ELCD (accessed on 22 December 2022).
55. OpenLca Nexus: Exiobase. Available online: https://nexus.openlca.org/database/exiobase (accessed on 22 December 2022).
56. OpenLca Nexus: NEEDS. Available online: https://nexus.openlca.org/database/NEEDS (accessed on 22 December 2022).
57. OpenLca Nexus: OpenLca. Available online: https://nexus.openlca.org/database/openLCA%20LCIA%20methods (accessed on 22 December 2022).
58. OpenLca Nexus: The Evah Institute. Available online: https://nexus.openlca.org/database/OzLCI2019 (accessed on 22 December 2022).
59. OpenLca Nexus: Worldsteel Association. Available online: https://nexus.openlca.org/database/worldsteel (accessed on 22 December 2022).
60. United States Environmental Protection Agency: GHG Emission Factors Hub. Available online: https://www.epa.gov/climateleadership/ghg-emission-factors-hub (accessed on 22 December 2022).
61. United States Environmental Protection Agency: Waste Transfer Stations: A Manual for Decision-Making. Available online: https://www.epa.gov/sites/default/files/2016-03/documents/r02002.pdf (accessed on 22 December 2022).
62. Dominic, C.A.; Östlund, S.; Buffington, J.; ,Masoud, M.M. Towards a conceptual sustainable packaging development model: A corrugated box case study. Packag. Technol. Sci. 2015, 28, 397-413. https://doi.org/10.1002/pts.2113.

63. Su, Y.; Duan, H.; Wang, Z.; Song, G.; Kang, P.; Chen, D. Characterizing the environmental impact of packaging materials for express delivery via life cycle assessment. J. Clean. Prod. 2020, 274, 122961. https://doi.org/10.1016/j.jclepro.2020.122961.
64. Koskela, S.; Dahlbo, H.; Judl, J.; Korhonen, M.R.; Niininen, M. Reusable plastic crate or recyclable cardboard box? A comparison of two delivery systems. J. Clean. Prod. 2014, 69, 83-90. https://doi.org/10.1016/j.jclepro.2014.01.045.
65. ULINE: 18 × 18 × 18" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-4185/Corrugated-Boxes-200-Test/18-x-18-x-18-Corrugated-Boxes (accessed on 24 December 2022).
66. Ackerman, F.; Stanton, E.A. Climate risks and carbon prices: Revising the social cost of carbon. Economics 2012, 6, 1-25. http://dx.doi.org/10.5018/economics-ejournal.ja.2012-10.
67. ULINE: 20 x 18 x 16" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-4795/Corrugated-Boxes-200-Test/20-x-18-x-16-Corrugated-Boxes (accessed on 24 December 2022).
68. ULINE: 20 x 16 x 20" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-23993/Corrugated-Boxes-200-Test/20-x-16-x-20-Corrugated-Boxes (accessed on 24 December 2022).
69. ULINE: 20 x 12 x 12" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-12603/Heavy-Duty-Boxes/20-x-12-x-12-275-lb-Double-Wall-Corrugated-Boxes (accessed on 24 December 2022).
70. ULINE: 19 x 19 x 19" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-4860/Corrugated-Boxes-200-Test/19-x-19-x-19-Corrugated-Boxes (accessed on 24 December 2022).
71. ULINE: 18 x 18 x 8" Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-14232/Heavy-Duty-Boxes/18-x-18-x-8-275-lb-Double-Wall-Corrugated-Boxes (accessed on 24 December 2022).

72. ULINE: 18 x 18 x 12” Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-4399/Corrugated-Boxes-200-Test/18-x-18-x-12-Corrugated-Boxes (accessed on 24 December 2022).
73. ULINE: 20 x 18 x 18” Corrugated Boxes. Available online: https://www.uline.com/Product/Detail/S-14286/Corrugated-Boxes-200-Test/20-x-18-x-18-Corrugated-Boxes (accessed on 24 December 2022).
74. https://www.epa.gov/sustainability/learn-about-sustainability
75. https://www.un.org/en/climatechange/science/causes-effects-climate-change

APPENDIX A

Table A.1 Analysis of multiple-choice questions based on age.

		18 to 30			31 to 45			46 plus			Prefer not to mention		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q7	Ethos	46	28.69	<0.00001	46	24.89	<0.00001	33	20.63	<0.00001	5	5.00	0.0254
	Pathos	7			9			5			0		
Q8	Ethos	28	0.17	0.68	36	5.26	0.0219	26	5.16	0.02314	3	0.20	0.6547
	Logos	25			19			12			2		
Q9	Ethos	20	3.19	0.0742	24	0.89	0.3452	20	0.11	0.7456	2	0.20	0.6547
	Aesthetics	33			31			18			3		
Q10	Pathos	17	6.81	0.0091	33	2.20	0.138	23	1.68	0.19437	3	0.20	0.6547
	Logos	36			22			15			2		
Q11	Pathos	8	25.83	<0.00001	12	17.47	0.00003	9	10.53	0.00118	1	1.80	0.1797
	Aesthetics	45			43			29			4		
Q12	Logos	22	1.53	0.2164	14	13.26	0.00027	6	17.79	0.00002	1	1.80	0.1797
	Aesthetics	31			41			32			4		
Q13	Ethos	46	28.69	<0.00001	45	22.27	<0.00001	33	20.63	<0.00001	5	5.00	0.0254
	Pathos	7			10			5			0		
Q14	Ethos	22	1.53	0.2164	33	2.20	0.13801	23	1.68	0.19437	3	0.20	0.6547
	Logos	31			22			15			2		
Q15	Ethos	20	3.19	0.00742	28	0.02	0.89274	19	0.00	1	2	0.20	0.6547
	Aesthetics	33			27			19			3		
Q16	Pathos	17	6.81	0.0091	25	0.46	0.50018	20	0.11	0.7456	3	0.20	0.6547
	Logos	36			30			18			2		

		18 to 30			31 to 45			46 plus			Prefer not to mention		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q17	Pathos	8	25.83	<0.00001	9	24.89	<0.00001	10	8.53	0.0035	1	1.80	0.1797
	Aesthetics	45			46			28			4		
Q18	Logos	29	0.47	0.4922	23	1.47	0.22492	8	12.74	0.00036	1	1.80	0.1797
	Aesthetics	24			32			30			4		
Q19	Positive Reinforcement	23	0.93	0.3363	30	0.46	0.50018	28	8.53	0.0035	4	1.80	0.1797
	Positive Punishment	30			25			10			1		
Q20	Positive Reinforcement	30	0.93	0.3363	36	5.26	0.02189	23	1.68	0.19437	3	0.20	0.6547
	Negative Punishment	23			19			15			2		
Q21	Positive Reinforcement	24	0.47	0.4922	22	2.20	0.13801	18	0.11	0.7456	2	0.20	0.6547
	Negative Reinforcement	29			33			20			3		
Q22	Positive Punishment	40	13.76	0.0002	36	5.26	0.02189	10	8.53	0.0035	1	1.80	0.1797
	Negative Punishment	13			19			28			4		
Q23	Positive Punishment	30	0.93	0.3363	25	0.46	0.50018	9	10.53	0.00118	0	5.00	0.0254
	Negative Reinforcement	23			30			29			5		
Q24	Negative Punishment	19	4.25	0.0394	17	8.02	0.00463	5	20.63	<0.00001	1	1.80	0.1797
	Negative Reinforcement	34			38			33			4		
Q25	Positive Reinforcement	31	1.53	0.2164	29	0.16	0.68583	29	10.53	0.00118	4	1.80	0.1797
	Positive Punishment	22			26			9			1		
Q26	Positive Reinforcement	41	15.87	0.00007	36	5.26	0.02189	24	2.63	0.10476	4	1.80	0.1797
	Negative Punishment	12			19			14			1		
Q27	Positive Reinforcement	32	2.28	0.1308	28	0.02	0.89274	17	0.42	0.51641	2	0.20	0.6547
	Negative Reinforcement	21			27			21			3		
Q28	Positive Punishment	39	11.79	0.00059	32	1.47	0.22492	14	2.63	0.10476	1	1.80	0.1797
	Negative Punishment	14			23			24			4		
Q29	Positive Punishment	36	6.81	0.00906	26	0.16	0.68583	7	15.16	0.0001	0	5.00	0.0254
	Negative Reinforcement	17			29			31			5		
Q30	Negative Punishment	21	2.28	0.1308	16	9.62	0.00193	9	10.53	0.00118	0	5.00	0.0254

		18 to 30			31 to 45			46 plus			Prefer not to mention		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
	Negative Reinforcement	32			39			29			5		

Table A.2 Analysis of multiple-choice questions based on gender.

		Male			Female			Prefer not to mention			Non-binary		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q7	Ethos	60	37.70	<0.00001	65	369.48	<0.00001	3	3.00	0.08326	2	2	0.1573
	Pathos	9			12			0			0		
Q8	Ethos	42	3.26	0.07095	47	3.75	0.05271	2	0.33	0.5637	2	2	0.1573
	Logos	27			30			1			0		
Q9	Ethos	32	0.36	0.54722	32	2.20	0.13848	1	0.33	0.5637	1	0	1
	Aesthetics	37			45			2			1		
Q10	Pathos	39	1.17	0.2786	34	1.05	0.30506	2	0.33	0.5637	1	0	1
	Logos	30			43			1			1		
Q11	Pathos	12	29.35	<0.00001	18	21.83	<0.00001	0	3.00	0.08326	0	2	0.1573
	Aesthetics	57			59			3			2		
Q12	Logos	16	19.84	<0.00001	26	8.12	0.00439	1	0.33	0.5637	0	2	0.1573
	Aesthetics	53			51			2			2		
Q13	Ethos	59	34.80	<0.00001	65	369.48	<0.00001	3	3.00	0.08326	2	2	0.1573
	Pathos	10			12			0			0		
Q14	Ethos	41	2.45	0.11758	37	0.12	0.73244	2	0.33	0.5637	1	0	1
	Logos	28			40			1			1		
Q15	Ethos	34	0.01	0.90418	33	1.57	0.21	1	0.33	0.5637	1	0	1
	Aesthetics	35			44			2			1		
Q16	Pathos	36	0.13	0.71798	26	8.12	0.00439	2	0.33	0.5637	1	0	1
	Logos	33			51			1			1		

		Male			Female			Prefer not to mention			Non-binary		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q17	Pathos	13	26.80	<0.00001	15	28.69	<0.00001	0	3.00	0.08326	0	2	0.1573
	Aesthetics	56			62			3			2		
Q18	Logos	25	5.23	0.02218	34	1.05	0.30506	1	0.33	0.5637	1	0	1
	Aesthetics	44			43			2			1		
Q19	Positive Reinforcement	41	2.45	0.11758	41	0.33	0.56881	3	3.00	0.08326	0	2	0.1573
	Positive Punishment	28			36			0			2		
Q20	Positive Reinforcement	39	1.17	0.2786	51	8.12	0.00439	2	0.33	0.5637	0	2	0.1573
	Negative Punishment	30			26			1			2		
Q21	Positive Reinforcement	30	1.17	0.2786	32	2.20	0.13848	2	0.33	0.5637	2	2	0.1573
	Negative Reinforcement	39			45			1			0		
Q22	Positive Punishment	33	0.13	0.71798	53	10.92	0.00095	0	3.00	0.08326	1	0	1
	Negative Punishment	36			24			3			1		
Q23	Positive Punishment	27	3.26	0.07095	36	0.33	0.56881	0	3.00	0.08326	1	0	1
	Negative Reinforcement	42			41			3			1		
Q24	Negative Punishment	18	15.78	0.00007	22	14.14	0.00017	1	0.33	0.5637	1	0	1
	Negative Reinforcement	51			55			2			1		
Q25	Positive Reinforcement	45	6.39	0.01147	45	2.20	0.13848	3	3.00	0.08326	0	2	0.1573
	Positive Punishment	24			32			0			2		
Q26	Positive Reinforcement	42	3.26	0.07095	59	21.83	<0.00001	3	3.00	0.08326	1	0	1
	Negative Punishment	27			18			0			1		
Q27	Positive Reinforcement	35	0.01	0.90418	41	0.33	0.56881	2	0.33	0.5637	1	0	1
	Negative Reinforcement	34			36			1			1		
Q28	Positive Punishment	34	0.01	0.90418	50	6.87	0.00876	0	3.00	0.08326	2	2	0.1573
	Negative Punishment	35			27			3			0		
Q29	Positive Punishment	26	4.19	0.0407	41	0.33	0.56881	0	3.00	0.08326	2	2	0.1573
	Negative Reinforcement	43			36			3			0		
Q30	Negative Punishment	22	9.06	0.00262	23	12.48	0.00041	0	3.00	0.08326	1	0	1
	Negative Reinforcement	47			54			3			1		

Table A.3 Analysis of multiple-choice questions based on awareness.

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q7	Ethos	20	10.67	0.00109	66	45.46	<0.00001	41	22.22	<0.00001	3	1	0.31731	0	-	-
	Pathos	4			8			8			1			0		
Q8	Ethos	12	0.00	1	49	7.78	0.00527	29	1.65	0.19854	3	1	0.31731	0	-	-
	Logos	12			25			20			1			0		
Q9	Ethos	12	0.00	1	31	1.95	0.16302	20	1.65	0.19854	3	1	0.31731	0	-	-
	Aesthetics	12			43			29			1			0		
Q10	Pathos	9	1.50	0.22067	40	0.49	0.4855	25	0.02	0.8864	2	0.00	1	0	-	-
	Logos	15			34			24			2			0		
Q11	Pathos	5	8.17	0.00427	13	31.14	<0.00001	10	17.16	0.00003	2	0.00	1	0	-	-
	Aesthetics	19			61			39			2			0		
Q12	Logos	7	4.17	0.04123	20	15.62	0.00008	15	7.37	0.00664	1	1	0.31731	0	-	-
	Aesthetics	17			54			34			3			0		
Q13	Ethos	20	10.67	0.00109	66	45.46	<0.00001	41	22.22	<0.00001	2	0.00	1	0	-	-
	Pathos	4			8			8			2			0		
Q14	Ethos	12	0.00	1	43	1.95	0.16302	23	0.18	0.66824	3	1	0.31731	0	-	-
	Logos	12			31			26			1			0		
Q15	Ethos	12	0.00	1	37	0.00	1	18	3.45	0.06329	2	0.00	1	0	-	-
	Aesthetics	12			37			31			2			0		
Q16	Pathos	9	1.50	0.22067	33	0.87	0.35238	20	1.65	0.19854	3	1	0.31731	0	-	-
	Logos	15			41			29			1			0		
Q17	Pathos	5	8.17	0.00427	14	28.60	<0.00001	7	25.00	<0.00001	2	0.00	1	0	-	-
	Aesthetics	19			60			42			2			0		
Q18	Logos	8	2.67	0.10247	31	1.95	0.16302	20	1.65	0.19854	2	0.00	1	0	-	-
	Aesthetics	16			43			29			2			0		
Q19	Positive Reinforcement	12	0.00	1	44	2.65	0.10364	28	1.00	0.31731	1	1	0.31731	0	-	-
	Positive Punishment	12			30			21			3			0		
Q20	Positive Reinforcement	15	1.50	0.22067	43	1.95	0.16302	33	5.90	0.01516	1	1	0.31731	0	-	-

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
	Negative Punishment	9			31			16			3			0		
Q21	Positive Reinforcement	6	6.00	0.01431	37	0.00	1	22	0.51	0.47505	1	1	0.31731	0	-	-
	Negative Reinforcement	18			37			27			3			0		
Q22	Positive Punishment	12	0.00	1	40	0.49	0.4855	33	5.90	0.01516	2	0.00	1	0	-	-
	Negative Punishment	12			34			16			2			0		
Q23	Positive Punishment	8	2.67	0.10247	33	0.87	0.35238	21	1.00	0.31731	2	0.00	1	0	-	-
	Negative Reinforcement	16			41			28			2			0		
Q24	Negative Punishment	3	13.50	0.00024	23	10.60	0.00113	15	7.37	0.00664	1	1	0.31731	0	-	-
	Negative Reinforcement	21			51			34			3			0		
Q25	Positive Reinforcement	15	1.50	0.22067	49	7.78	0.00527	27	0.51	0.47505	2	0.00	1	0	-	-
	Positive Punishment	9			25			22			2			0		
Q26	Positive Reinforcement	15	1.50	0.22067	51	10.60	0.00113	36	10.80	0.00102	3	1	0.31731	0	-	-
	Negative Punishment	9			23			13			1			0		
Q27	Positive Reinforcement	10	0.67	0.41422	40	0.49	0.4855	28	1.00	0.31731	1	1	0.31731	0	-	-
	Negative Reinforcement	14			34			21			3			0		
Q28	Positive Punishment	13	0.17	0.68309	39	0.22	0.64194	31	3.45	0.06329	3	1	0.31731	0	-	-
	Negative Punishment	11			35			18			1			0		
Q29	Positive Punishment	9	1.50	0.22067	33	0.87	0.35238	25	0.02	0.8864	2	0.00	1	0	-	-
	Negative Reinforcement	15			41			24			2			0		

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q30	Negative Punishment	3	13.50	0.00024	23	10.60	0.00113	18	3.45	0.06329	2	0.00	1	0	-	-
	Negative Reinforcement	21			51			31			2			0		

Table A.4 Analysis of multiple-choice questions based on recycling efforts.

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q7	Ethos	5	1.29	0.25684	62	39.56	<0.00001	50	34.57	<0.00001	12	7.143	0.00753	1	0.333	0.5637
	Pathos	2			9			6			2			2		
Q8	Ethos	4	0.14	0.70546	45	5.09	0.02414	35	3.50	0.06137	7	0	1	2	0.333	0.5637
	Logos	3			26			21			7			1		
Q9	Ethos	4	0.14	0.70546	28	3.17	0.07505	29	0.07	0.78927	3	4.571	0.03251	2	0.333	0.5637
	Aesthetics	3			43			27			11			1		
Q10	Pathos	3	0.14	0.70546	35	0.01	0.90553	31	0.64	0.42268	5	1.14	0.28505	2	0.333	0.5637
	Logos	4			36			25			9			1		
Q11	Pathos	2	1.29	0.25684	13	28.52	<0.00001	11	20.64	<0.00001	2	7.143	0.00753	2	0.333	0.5637
	Aesthetics	5			58			45			12			1		
Q12	Logos	3	0.14	0.70546	18	7.25	0.0003	17	8.64	0.00328	4	2.571	0.10881	1	0.333	0.5637
	Aesthetics	4			53			39			10			2		
Q13	Ethos	5	1.29	0.25684	63	42.61	<0.00001	49	31.50	<0.00001	11	4.571	0.03251	1	0.333	0.5637
	Pathos	2			8			7			3			2		
Q14	Ethos	3	0.14	0.70546	35	0.01	0.90553	34	2.57	0.10881	7	0	1	2	0.333	0.5637
	Logos	4			36			22			7			1		
Q15	Ethos	4	0.14	0.70546	32	0.69	0.40612	29	0.07	0.78927	2	7.143	0.00753	2	0.333	0.5637
	Aesthetics	3			39			27			12			1		

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q16	Pathos	3	0.14	0.70546	25	6.21	0.01269	30	0.29	0.59298	5	1.14	0.28505	2	0.333	0.5637
	Logos	4			46			26			9			1		
Q17	Pathos	2	1.29	0.25684	12	31.11	<0.00001	10	23.14	<0.00001	2	7.143	0.00753	2	0.333	0.5637
	Aesthetics	5			59			46			12			1		
Q18	Logos	4	0.14	0.70546	26	5.09	0.02414	23	1.79	0.18145	7	0	1	1	0.333	0.5637
	Aesthetics	3			45			33			7			2		
Q19	Positive Reinforcement	6	3.57	0.5878	40	1.14	0.28547	30	0.29	0.59298	7	0	1	2	0.333	0.5637
	Positive Punishment	1			31			26			7			1		
Q20	Positive Reinforcement	4	0.14	0.70546	42	2.38	0.12288	33	1.79	0.18145	11	4.571	0.03251	2	0.333	0.5637
	Negative Punishment	3			29			23			3			1		
Q21	Positive Reinforcement	4	0.14	0.70546	32	0.69	0.40612	21	3.50	0.06137	7	0	1	2	0.333	0.5637
	Negative Reinforcement	3			39			35			7			1		
Q22	Positive Punishment	3	0.14	0.70546	39	0.69	0.40612	37	5.79	0.01616	7	0	1	1	0.333	0.5637
	Negative Punishment	4			32			19			7			2		
Q23	Positive Punishment	2	1.29	0.25684	29	2.38	0.12288	27	0.07	0.78927	6	0.29	0.59298	0	3	0.08326
	Negative Reinforcement	5			42			29			8			3		
Q24	Negative Punishment	0	7.00	0.00815	15	23.68	<0.00001	19	5.79	0.01616	8	0.29	0.59298	0	3	0.08326
	Negative Reinforcement	7			56			37			6			3		
Q25	Positive Reinforcement	6	3.57	0.5878	44	4.07	0.04364	33	1.79	0.18145	7	0	1	3	3	0.08326
	Positive Punishment	1			27			23			7			0		
Q26	Positive Reinforcement	4	0.14	0.70546	50	11.85	0.00058	38	7.14	0.00753	10	2.571	0.10881	3	3	0.08326
	Negative Punishment	3			21			18			4			0		
Q27	Positive Reinforcement	4	0.14	0.70546	38	0.35	0.55292	26	0.29	0.59298	9	1.14	0.28505	2	0.333	0.5637
	Negative Reinforcement	3			33			30			5			1		

		Tremendous			High			Moderate			Little			Very Little		
		Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value	Score	Chi^2 value	P-value
Q28	Positive Punishment	3	0.14	0.70546	39	0.69	0.40612	36	4.57	0.03251	6	0.29	0.59298	2	0.333	0.5637
	Negative Punishment	4			32			20			8			1		
Q29	Positive Punishment	1	3.57	0.5878	30	1.70	0.19174	30	0.29	0.59298	8	0.29	0.59298	0	3	0.08326
	Negative Reinforcement	6			41			26			6			3		
Q30	Negative Punishment	1	3.57	0.5878	17	19.28	0.00001	19	5.79	0.01616	9	1.14	0.28505	0	3	0.08326
	Negative Reinforcement	6			54			37			5			3		

Table A.5 Results of Likert scale questions based on age.

	18 to 30	31 to 45	46 plus	Prefer not to answer
Aesthetics	4.3962	4.3091	4.1474	3.8400
Ethos	4.4038	4.2509	3.9684	3.5600
Logos	3.6302	3.4327	3.2684	3.3200
Pathos	4.0566	4.0509	3.8737	3.3200

Table A.6 Analysis of Likert scale questions based on age.

Comparison of persuasion techniques	18 to 30		31 to 45		46 plus		Prefer not to answer	
	t-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value
Ethos with Pathos	2.4775	0.0191	1.6998	0.0638	0.6957	0.2532	1.5492	0.0800
Ethos with Logos	1.8073	0.0542	2.4253	0.0208	2.4144	0.0211	0.5535	0.2975

Aesthetics with Ethos	0.1021	0.4606	0.8224	0.2173	2.5702	0.0166	1.1918	0.1338
Aesthetics with Pathos	2.5767	0.0164	2.0424	0.0377	2.1454	0.0321	1.9941	0.0406
Aesthetics with Logos	1.8009	0.0547	2.5737	0.0165	3.0734	0.0076	1.0796	0.1559
Logos with Pathos	0.9654	0.1813	0.7500	0.0591	1.9587	0.0429	0.0000	0.5000

Table A.7 Results of Likert scale questions based on gender.

	Male	Female	Non-binary	Prefer not to mention
Aesthetics	4.2667	4.3169	4.3000	3.8000
Ethos	4.1362	4.2961	4.3000	3.6667
Logos	3.4667	3.4753	2.9000	3.1333
Pathos	3.9362	4.0494	3.9000	3.4667

Table A.8 Analysis of Likert scale questions based on gender.

Comparison of persuasion techniques	Male		Female		Non-binary		Prefer not to mention	
	t-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value
Ethos with Pathos	1.5922	0.0750	1.9404	0.0441	2.5298	0.0176	1.5000	0.0860
Ethos with Logos	2.5019	0.0184	1.9151	0.0459	2.4558	0.0198	0.9631	0.1819
Aesthetics with Ethos	2.1502	0.0319	0.3018	0.3852	0.0000	0.5000	1.0000	0.1733
Aesthetics with Pathos	2.5099	0.0182	2.2410	0.0277	2.5298	0.0176	1.7678	0.0575
Aesthetics with Logos	2.9573	0.0091	1.9739	0.0419	2.4558	0.0198	1.1704	0.1378
Logos with Pathos	1.6080	0.0733	1.3060	0.1139	1.7678	0.0575	0.5852	0.2873

Table A.9 Results of Likert scale questions based on awareness.

	Tremendous	High	Moderate	Little
Aesthetics	4.4417	4.2892	4.1592	4.7500
Ethos	4.5167	4.2216	4.0204	4.5000
Logos	3.2750	3.5027	3.4694	3.5500
Pathos	4.0833	4.0541	3.8286	4.0000

Table A.10 Analysis of Likert scale questions based on awareness.

Comparison of persuasion techniques	Tremendous		High		Moderate		Little	
	t-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value
Ethos with Pathos	3.1853	0.0064	1.6430	0.0695	1.1981	0.1326	1.5811	0.0763
Ethos with Logos	3.0815	0.0075	2.0952	0.0347	1.5162	0.0840	3.1667	0.0066
Aesthetics with Ethos	1.1339	0.1448	1.2492	0.1234	1.7712	0.0572	1.8257	0.0527
Aesthetics with Pathos	2.6849	0.0139	2.2757	0.0262	2.1002	0.0345	2.1764	0.0306
Aesthetics with Logos	2.9016	0.0099	2.2875	0.0257	1.9043	0.0467	3.6389	0.0033
Logos with Pathos	1.9279	0.0450	1.5565	0.0791	0.9252	0.1910	1.0324	0.1660

Table A.11 Results of Likert scale questions based on recycling efforts.

	Tremendous	High	Moderate	Little	Very Little
Aesthetics	4.0000	4.4423	4.1714	3.9714	4.7333
Ethos	3.6857	4.4225	4.0250	3.9714	5.0000
Logos	2.9143	3.4676	3.5429	3.4286	3.0000
Pathos	3.7429	4.2056	3.8250	3.4286	4.8667

Table A.12 Analysis of Likert scale questions based on recycling efforts.

Comparison of persuasion techniques	Tremendous		High		Moderate		Little		Very Little	
	t-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value	*t*-value	*p*-value
Ethos with Pathos	0.4851	0.3203	1.7764	0.0568	1.3724	0.1036	3.5590	0.0037	1.0000	0.1733
Ethos with Logos	1.5335	0.0818	2.4008	0.0216	1.5081	0.0850	1.6522	0.0686	7.1714	0.0001
Aesthetics with Ethos	2.5575	0.0169	0.2322	0.4111	2.7769	0.0120	0.0000	0.5000	1.3720	0.1037
Aesthetics with Pathos	2.4495	0.0200	1.8863	0.0480	2.4026	0.0215	2.4841	0.0189	0.5657	0.2936
Aesthetics with Logos	2.1705	0.0309	2.4440	0.0202	1.9705	0.0421	1.4916	0.0871	5.0990	0.0005
Logos with Pathos	1.6605	0.0677	1.8074	0.0542	0.8137	0.2197	0.0000	0.5000	6.0386	0.0002

APPENDIX B

Survey questionnaires for Survey #1:

Q1. Select one from the following options that you feel describes you the best of the four choices.

- While walking in the park, when I see a plastic bag on a footpath, I pick up the bag and throw it in the recycling bin to reduce pollution.
- I participate in a survey only if the organizer will give me some kind of cash reward.
- I would participate in a charity fundraiser program to help the needy.
- I prefer things based on their appearance over their performance.

Q2. Select one of the following that suits you best.

- If my company would give a reward to the employees who work on weekends, I would definitely work on some/all the weekends to get that reward.
- I prefer working late hours sometimes just to prevent the long lectures from my boss about not completing the task.
- Even if the street is empty, I would prefer to walk the extra distance to cross the street at a crosswalk rather than jaywalking. The penalty for jaywalking in Colorado can be up to $100.
- After hearing that I can be a potential candidate for a promotion, I am working more than usual because I fear I might lose the promotion opportunity if I don't work hard.

Q3. You are totally exhausted because of a busy week which was difficult and disappointing. How do you plan to spend your weekend? (Question modified from one originally presented on the Brightside website).

- I would call my friends to check on their plans for the weekend. I would then plan with everyone to go to one of the following: the newly-opened restaurant/the new highly-rated comedy in the cinemas/the paintball club.
- I will turn my phone to “silent mode” and stay at home. I would watch the new episode of my favorite TV series, do a puzzle, and take a long bath with a novel.

Q4. Which of the following descriptions suits you more? (Question modified from one originally presented on the Brightside website).

- I pay attention to details and assess real situations, because the most important thing for me is about what’s happening now and here.
- Facts are not so exciting! I love to play and dream over upcoming events in my mind as I rely more on intuition than on information.

Q5. A competitor of your current employer is trying to entice you. You have some doubts because the salary is much higher there when compared to the current employer. But the staff at your current employer is great. Moreover, the head of your department hinted that he will recommend you to be the boss when he retires. How are you going to make a decision? (Question modified from one originally presented on the Brightside website).

- I will find all the available information about the competitor and ask my HR manager for advice. I would then draw a chart with all the merits and demerits of both the companies. In such cases, it is important to weigh up all the advantages and disadvantages and assess the situation with a calm mind.
- I usually follow my heart! So, I will just listen to my feelings and make a decision.

Q6. Your close friends’ wedding is just two weeks away. How are your preparations going? (Question modified from one originally presented on the Brightside website).

- Three weeks ago, I brought a new suit for the wedding/chose the keyboard player who will play a medley of our school songs/collected the couple's photo love story/wrote a poem/made an appointment with the stylist. I prefer to be fully prepared.
- Why prepare? I will be enjoying myself at the party and having fun. I will improvise my wedding toast. The best things happen spontaneously.

Likert Scale questionnaire:

Five Options to each question below—(Strongly agree, Somewhat agree, Neither agree nor disagree, Somewhat disagree and Strongly disagree.)

Q7. I take additional effort to complete a task if I receive a cash reward after completing it.

Q8. I sometimes ignore going the extra mile even if I know I will be rewarded with cash.

Q9. I would walk for a mile to get to my destination rather than book a cab to save money.

Q10. I will devote a couple of hours per month to watch a short lecture per month if I receive a cash reward.

Q11. I don't participate in a survey if they don't give me some kind of reward (cash, coupon, etc), as I think it is a waste of my time.

Q12. I do things that are ethically correct even if I don't necessarily want to do them.

Q13. I would prefer driving an electric car over gasoline cars, even if the electric cars are costlier, because I believe it will reduce pollution.

Q14. I prefer plastic bags over fabric bags in grocery stores because fabric bags are expensive and plastic bags are free.

Q15. I would help my friend on an exam even if it is against my ethics because a friend in need is a friend indeed.

Q16. I would participate in an activity that is against my ethics if I get a suitable reward for it.

Q17. I sometimes feel bad for the less fortunate, so I donate food/money to them while coming from grocery shopping.

Q18. I would make a donation for cleaning random lakes or beaches in the world, because I fear that aquatic life will be affected by man-made pollution.

Q19. I would bring a souvenir from a fun place as a memory.

Q20. I try to reduce carbon emissions from my side because I fear global warming will affect human beings in the future.

Q21. I would choose the decision made by my mind over the heart.

Q22. I would choose a stylish car that has a great color/artwork on it over a boring-looking car with high mileage.

Q23. I prefer a restaurant with good food quality over a restaurant with a pleasant ambience.

Q24. I wear clothes that look good on me even if they are not that comfortable.

Q25. I like to decorate my room with the cool things that I like.

Q26. I would buy option “b” over “a”. Even if “b” is expensive. (Refer Figure A1).

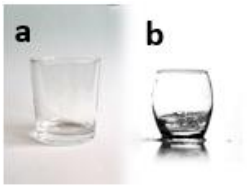


Figure A1. Reference figure comparing two glasses.

Q27. I tend to complete my work on time, before deadline, to impress my boss and receive praise.

Q28. If I know I could receive a reward for completing some tasks, I give my 100% to complete that task.

Q29. I would think of buying an electric car because the federal government gives tax credits to those who buy an electric vehicle.

Q30. I tend to make an extra effort in my work only when I know I will be rewarded for doing it.

Q31. I would usually travel an extra mile for a coffee if I know I will be rewarded by the best coffee in the town!

Q32. I like to clean my work desk every day so that I avoid losing important documents/things.

Q33. I try to complete assignments before deadline to avoid penalties.

Q34. I always charge my phone/carry a power bank before leaving home to avoid having a discharged phone.

Q35. While cooking I tend to use less salt than the recipe calls for, as I can always add salt later.

Q36. I tend to charge my laptop before a meeting to avoid running out of power during the meeting.

Q37. I avoid working overtime, even if my work is past deadline, since I could be penalized for going into overtime.

Q38. I avoid jaywalking even on a side street to avoid a fine.

Q39. I try to pay my credit card bill on time because if I don't, they would penalize me.

Q40. I try to pay my rent on time because if I don't, my landlord penalizes me.

Q41. I always avoid parking my car in no parking area because if I do, the authorities can tow my vehicle.

Q42. I pay the Wi-Fi bill on time because if don't then I could lose Wi-Fi as well as my TV privileges that come with it.

Q43. I work hard at my job because I know my boss can demote me if I don't.

Q44. I keep on subscribing to Amazon prime so that I can get prime delivery as well as prime video privileges.

Q45. I always maintain the minimum balance on my debit card to avoid losing my cash reward.

Q46. I avoid being late to work because I don't like to miss the best parking slot. Multiple-choice questions below:

Q47. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Congratulations! Recycling this box will give you "5" dollars. Recycling 2 boxes/month could give you "120" dollars/year!
- Congratulations! You are contributing to saving the planet earth!
- Thank you! Your recycling of this box is contributing to healing the ozone layer!
- Good job! By recycling this box you are keeping our environment clean.

Q48. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Recycling this box will save 20% of the shipping charges on your mail.
- Recycling "20" boxes will save "5" liters of oil which would contribute to preventing Global Warming.
- Thank you! Your recycling of this box is contributing to saving Florida panthers.
- Good job! By recycling this box you are preventing it from adding it to the landfill.

Q49. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Failing to recycle this box will get you off the priority delivery option for your mail/package delivery: only people who recycle 5 boxes/month get to be on the priority delivery list.
- Failing to recycle this box will increase pollution by 3 kgCO2eq. amount of carbon emission.
- Failing to recycle this box will increase global warming.
- Failing to recycle this box will increase the dirty landfills.

Q50. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Failing to recycle this box will prevent you from getting a discount on the shipping cost.
- Failing to recycle this box will increase the depletion of fossil fuels.
- Failing to recycle this box will decrease the chances of saving polar bears.
- Failing to recycle this box will make our environment dirty.

Q51. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Congratulations! Recycling this box will give you “5” dollars. Recycling 2 boxes/month could give you “120” dollars/year!
- Recycling this box will save 20% of the shipping charges on your mail.
- Failing to recycle this box will get you off the priority delivery option for your mail/package delivery: only people who recycle 5 boxes/month get to be on the priority delivery list.
- Failing to recycle this box will prevent you from getting a discount on the shipping cost.

Q52. Select one of the following options which appeal to you the most for recycling cardboard boxes. Z

- Congratulations! You are contributing to saving the planet!
- Recycling “20” boxes will save “5” liters of oil which would contribute to preventing Global Warming.
- Failing to recycle this box will increase pollution by 3 kgCO2eq. amount of carbon emission.
- Failing to recycle this box will increase the depletion of fossil fuels.

Q53. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Thank you! Your recycling of this box is contributing to healing the ozone layer!
- Thank you! Your recycling of this box is contributing to saving Florida panthers.
- Failing to recycle this box will increase Global warming.
- Failing to recycle this box will decrease the chances of saving polar bears.

Q54. Select one of the following options which appeal to you the most for recycling cardboard boxes.

- Good job! By recycling this box, you are keeping our environment clean.
- Good job! By recycling this box, you are preventing it from being added to the landfill.
- Failing to recycle this box will increase the size of the landfill.
- Failing to recycle this box will make our environment dirty.

Q55. Please provide your personality type if you can. (If you don’t know, you can use this website 36] (optional). Text entry - _____

True or False questions below:

Q56. It is easy for me to make new friends.

Q57. I like to initiate talking even if it is with a stranger.

Q58. I tend to think more about the future than the present.

Q59. I tend to think more conceptually than practically.

Q60. For me, fair judgment is more important than compassion.

Q61. For me, appreciation is more important than the medals I receive.

Q62. I prefer my vacations to be spontaneous rather than planned.

Q63. I don’t like routines.

APPENDIX C

Survey questionnaires for Survey #2:

The first question is different in survey #2. This question was dependent on the participants' operant conditioning preferences and persuasion preferences. The four options for this question were $1/reused cardboard box, $3/reused cardboard box, $5/reused cardboard box, and another amount which is more than $5/reused box (please specify). So, there are fifteen unique first questions as follows:

Positive Reinforcement Aesthetic:

We want to incentivize you by donating to the charitable organization of your choice that prevents the addition of trash in the landfills for each cardboard box you reuse. What is the minimum amount of money that should be donated for you to reuse the boxes instead of disposing of them?

Positive Reinforcement Logos:

We want to incentivize you by giving a cash reward for each cardboard box you reuse. What is the minimum amount of money that should be rewarded for you to reuse the boxes instead of disposing of them?

Positive Reinforcement Ethos:

We want to incentivize you by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. What is the minimum amount of money that should be donated for you to reuse the boxes instead of disposing of them? Positive Reinforcement Pathos:

We want to incentivize you by donating to the charitable organization of your choice that is making an effort to heal the ozone layer for each cardboard box you reuse. What is the minimum amount of money that should be donated for you to reuse the boxes instead of disposing them?

Negative Reinforcement Aesthetics:

We want to incentivize you by donating to the charitable organization of your choice that cleans the trash in your city for each cardboard box you reuse. What is the minimum amount of money that should be donated for you to reuse the boxes instead of disposing of them?

Negative Reinforcement Logos:

We want to incentivize you by saving money off your shipping charges on your mail for every cardboard box you reuse. What is the minimum amount of money that should be saved in the shipping charges for you to reuse the boxes instead of disposing of them?

Negative Reinforcement Ethos:

We want to incentivize you by donating to the charitable organization of your choice that is making an effort to prevent global warming for each cardboard box you reuse. What is the minimum amount of money that should be donated for you to reuse the boxes instead of disposing of them?

Negative Reinforcement Pathos—No participant in this category

Positive Punishment Aesthetics:

We want to incentivize you by threatening to eliminate the donation to the charitable organization that is making an effort to decrease the dirty landfills for every cardboard box you fail to reuse. What is the minimum amount of money that, if eliminated from the donation, would incentivize you to reuse the boxes instead of disposing of them?

Positive Punishment Logos:

We want to incentivize you by threatening to increase the shipping charges on your mail for every cardboard box you fail to reuse. What is the minimum amount of money that, if increased in the shipping cost would incentivize you to reuse the boxes instead of disposing of them?

Positive Punishment Ethos:

We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. What is the minimum amount of money that, if eliminated from the donation, would incentivize you to reuse the boxes instead of disposing of them?

Positive Punishment Pathos:

We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. What is the minimum amount of money if eliminated from the donation would incentivize you to reuse the boxes instead of disposing them?

Negative Punishment Aesthetics:

We want to incentivize you by the threat of eliminating the donation of your share to the charitable organization that is making an effort to keep our environment clean for every cardboard box you fail to reuse. What is the minimum amount of money that, if eliminated from the donation, would incentivize you to reuse the boxes instead of disposing of them?

Negative Punishment Logos:

We want to incentivize you by threatening to eliminate the cash reward for every cardboard box you fail to reuse. What is the minimum amount of money that, if eliminated from the cash reward, would incentivize you to reuse the boxes instead of disposing of them?

Negative Punishment Ethos:

We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. What is the minimum amount of money that, ifeliminated from the donation, would incentivize you to reuse the boxes instead of disposing of them?

Negative Punishment Pathos:

We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. What is the minimum amount of money if eliminated from the donation would incentivize you to reuse the boxes instead of disposing of them?

The remaining 12 multiple-choice questions were dependent upon the participants' persuasion preferences. The four options to this question were $1/reused cardboard box, $3/reused cardboard box, $5/reused cardboard box, and another amount which is more than $5/reused box (please specify). So, below are the four sets of 12 questions that were asked in survey #2 depending upon the participants' persuasion preferences:

Persuasion preferences—Aesthetics:

Q2. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that prevents the addition of trash to the landfill for each cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that cleans

the trash in your city for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q3. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that cleans the trash in your city for each cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that prevents the addition of trash in the landfills for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q4. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that cleans the trash in your city for each cardboard box you reuse. (New plan)—We want to incentivize you by the threat of eliminating the donation of your share to the charitable organization that is making an effort to keep our environment clean for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q5. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that is making an effort to keep our environment clean for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is trying to keep our environment clean for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q6. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is keeping our environment clean for each cardboard box you reuse. (New plan)— We want to incentivize you by threatening to eliminate the donation to the charitable organization that is making an effort to decrease the dirty landfills for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q7. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that is making an effort to decrease the dirty landfills for every cardboard box you fail to reuse. Eliminating this donation increases the dirty landfills in your city. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to keep our environment clean for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q8. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that prevents the addition of waste in landfills for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization that is making an effort to decrease the dirty landfill for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q9. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that cleans the trash in your city for each cardboard box that you fail to reuse.

Eliminating this donation increases the dirty landfills in your city. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that prevents the addition of waste in the landfills for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q10. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that prevents the addition of waste in the landfills for each cardboard box you reuse. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization that is making an effort to keep our environment clean for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q11. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that is making an effort to keep our environment clean for each cardboard box you reuse. Eliminating this donation would make our city dirty. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to prevent the addition of waste to the landfills for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q12. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that cleans the trash in your city for each cardboard box you reuse. Eliminating this donation would increase the trash in the city. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization that works to clean up trash in

the city and landfill for each cardboard box you reuse. Eliminating this donation will take away the chances of cleaning our city. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q13. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization that works to clean up trash in the city and landfill for each cardboard box you reuse. Eliminating this donation would take away the chances of cleaning our city. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization that cleans the trash in your city for each cardboard box you reuse. Eliminating this donation will increase the trash in the city. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Persuasion preferences—Logos:

Q2. (Current plan)—Currently you are being incentivized by getting a cash reward for each cardboard box you reuse. (New plan)—We want to incentivize you by saving money off your shipping charges on your mail for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be saved in the new plan for you to reuse the boxes instead of disposing of them?

Q3. (Current plan)—Currently you are being incentivized by saving money off your shipping charges on your mail for every cardboard box you reuse. (New plan)—We want to incentivize you by giving you a cash reward for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be rewarded in the new plan for you to reuse the boxes instead of disposing of them?

Q4. (Current plan)—Currently you are being incentivized by getting a cash reward for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the cash reward for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q5. (Current plan)—Currently you are being incentivized by the threat of eliminating the cash reward for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by giving a cash reward for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be rewarded in the new plan for you to reuse the boxes instead of disposing of them?

Q6. (Current plan)—Currently you are being incentivized by getting a cash reward for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to increase the shipping charges on your mail for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if increased in the shipping cost in the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q7. (Current plan)—Currently you are being incentivized by the threat of increasing the shipping charges on your mail for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by giving a cash reward for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be rewarded in the new plan for you to reuse the boxes instead of disposing of them?

Q8. (Current plan)—Currently you are being incentivized by saving money off your shipping charges on your mail for every cardboard box you reuse. (New plan)—We want to incentivize you by threatening to increase the shipping charges on your mail for every cardboard box you fail to reuse. We want to move

you from your current incentivization plan to the new one. What is the minimum amount of money that, if increased in the shipping cost in the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q9. (Current plan)—Currently you are being incentivized by threatening to increase the shipping charges on your mail for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by saving money off your shipping charges on your mail for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be saved in the new plan for you to reuse the boxes instead of disposing of them?

Q10. (Current plan)—Currently you are being incentivized by saving money off your shipping charges on your mail for every cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the cash reward for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q11. (Current plan)—Currently you are being incentivized by threatening to eliminate the cash reward for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by saving money off your shipping charges on your mail for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be saved in the new plan for you to reuse the boxes instead of disposing of them?

Q12. (Current plan)—Currently you are being incentivized by the threat of increasing the shipping charges on your mail for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by the threat of eliminating the cash reward for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan would incentivize you to reuse the boxes instead of disposing of them?

Q13. (Current plan)—Currently you are being incentivized by the threat of eliminating the cash reward for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by threatening to increase the shipping charges on your mail for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if increased in the shipping cost in the new plan would incentivize you to reuse the boxes instead of disposing of them?

Persuasion preferences—Ethos:

Q2. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to prevent global warming for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q3. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to prevent global warming for each cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q4. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every

cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q5. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q6. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q7. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is trying to reduce pollution to save the planet for every cardboard box you reuse. We want to move you from your current

incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q8. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to prevent global warming for each cardboard box you reuse. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q9. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort in preventing global warming for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q10. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to prevent global warming for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q11. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort in preventing global warming for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing of them?

Q12. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse carboard box would increase pollution. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Q13. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease the depletion of fossil fuel for every cardboard box you fail to reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease pollution for every cardboard box you fail to reuse. Thus, failing to reuse the cardboard box would increase pollution. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that, if eliminated from the new plan, would incentivize you to reuse the boxes instead of disposing of them?

Persuasion preferences—Pathos:

Q2. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice (that is making an effort to heal the ozone layer) for each cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to save Florida panthers for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q3. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to save Florida panthers for each cardboard box you reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to heal the ozone layer for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q4. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to heal the ozone layer for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

Q5. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort in saving polar bears for each cardboard box you fail to reuse. (New plan)—We want to incentivize you by donating to the charitable organization

of your choice that is making an effort to heal the ozone layer for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q6. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to heal the ozone layer for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

Q7. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Which increases the global warming. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort in healing the ozone layer for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q8. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort in saving Florida panthers for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort in decreasing global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. We want to move you from your

current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

Q9. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to save Florida panthers for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q10. (Current plan)—Currently you are being incentivized by donating to the charitable organization of your choice that is making an effort to save Florida panthers for each cardboard box you reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

Q11. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. (New plan)—We want to incentivize you by donating to the charitable organization of your choice that is making an effort to save Florida panthers for each cardboard box you reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money that should be donated in the new plan for you to reuse the boxes instead of disposing them?

Q12. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. (New plan)—We want to incentivize you by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

Q13. (Current plan)—Currently you are being incentivized by the threat of eliminating the donation to the charitable organization of your choice that is making an effort to save polar bears for each cardboard box you fail to reuse. (New plan)—We want to incentivize you by threatening to eliminate the donation to the charitable organization of your choice that is making an effort to decrease global warming for each cardboard box you fail to reuse. Eliminating this donation increases global warming. We want to move you from your current incentivization plan to the new one. What is the minimum amount of money if eliminated from the new plan for you to reuse the boxes instead of disposing them?

The remaining 12 questions were qualitative questions, following every question from Q2 onwards. The qualitative question was an optional and open-ended question. The question asked was: “Please justify your answer to the previous question if possible. (Optional question)”.

APPENDIX D

Survey questionnaires for Survey #3:

Q1 Definitions:

Recycling process – You place the cardboard box in the dedicated recycle bin or return it to the dedicated recycling yard, which is then recycled to make a new cardboard box.

Reusing process – You place the cardboard box in the dedicated reuse bin or return it to the dedicated reuse yard, where it is reused for shipping goods, and then the cardboard box is cleaned and prepared for another use.

- I understood the difference between these two processes.

Q2 Please enter your email id - _____

Q3 What gender do you identify as?

- Male
- Female
- Non-binary
- Prefer not to answer

Q4 What is your age?

- 0 – 17 years old
- 18 – 30 years old
- 31 – 45 years old
- 46+

- Prefer not to answer

Q5 What are your current recycling efforts?

- Very Little
- Little
- Moderate
- High
- Tremendous

Q6 How much awareness do you have of the environment and climate change?

- Very Little
- Little
- Moderate
- High
- Tremendous

Q7 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I assign to the reusing process.
- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I assign to the reusing process.

Q8 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I assign to the reusing process.
- I get a suitable cash reward for each box I assign to the reusing process.

Q9 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I assign to the reusing process.
- A charitable organization committed to keeping my city clean gets a suitable donation for each box I assign to the reusing process.

Q10 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I assign to the reusing process.
- I get a suitable cash reward for each box I assign to the reusing process.

Q11 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I assign to the reusing process.
- A charitable organization committed to keeping my city clean gets a suitable donation for each box I assign to the reusing process.

Q12 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get a suitable cash reward for each box I assign to the reusing process.
- A charitable organization committed to keeping my city clean gets a suitable donation for each box I assign to the reusing process.

Q13 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I return to the reuse yard.
- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I return to the reuse yard.

Q14 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I return to the reuse yard.
- I get a suitable cash reward for each box I return to the reuse yard.

Q15 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I return to the reuse yard.

- A charitable organization committed to keeping my city clean gets a suitable donation for each box I return to the reuse yard.

Q16 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I return to the reuse yard.
- I get a suitable cash reward for each box I return to the reuse yard.

Q17 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I return to the reuse yard.
- A charitable organization committed to keeping my city clean gets a suitable donation for each box I return to the reuse yard.

Q18 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get a suitable cash reward for each box I return to the reuse yard.
- A charitable organization committed to keeping my city clean gets a suitable donation for each box I return to the reuse yard.

Q19 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get a suitable cash reward for each box I assign to the reuse process.
- I get penalized with a suitable cash penalty for not assigning the boxes to the reuse process.

Q20 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get a suitable cash reward for each box I assign to the reuse process.
- My product discount is taken away from me which was offered to me for every cardboard box I assign to the reuse process.

Q21 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get a suitable cash reward for each box I assign to the reuse process.
- My shipping charges are waived after I assign a suitable number of boxes to the reuse process.

Q22 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get penalized with a suitable cash penalty for not assigning the boxes to the reuse process.
- My product discount is taken away from me which was offered to me for every cardboard box I assign to the reuse process.

Q23 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- I get penalized with a suitable cash penalty for not assigning the boxes for the reusing process.
- My shipping charges are waived after I assign a suitable number of boxes to the reuse process.

Q24 Which one is more likely to influence you for assigning the cardboard box to the reuse bin rather than the recycling bin–

- My product discount is taken away from me which was offered to me for every cardboard box I assign to the reuse process.
- My shipping charges are waived after I assign a suitable number of boxes to the reuse process.

Q25 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get a suitable cash reward for each box I return to the reuse yard.
- I get penalized with a suitable cash penalty for not returning the boxes to the reuse yard.

Q26 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get a suitable cash reward for each box I return to the reuse yard.
- My product discount is taken away from me which was offered to me for every cardboard box I return to the reuse yard.

Q27 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get a suitable cash reward for each box I return to the reuse yard.
- My shipping charges are waived after I return a suitable number of boxes to the reuse yard.

Q28 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get penalized with a suitable cash penalty for not returning the boxes to the reuse yard.
- My product discount is taken away from me which was offered to me for every cardboard box I return to the reuse yard.

Q29 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- I get penalized with a suitable cash penalty for not returning the boxes to the reuse yard.
- My shipping charges are waived after I return a suitable number of boxes to the reuse yard.

Q30 Which one is more likely to influence you for returning the cardboard box to the reuse yard rather than the recycling yard –

- My product discount is taken away from me which was offered to me for every cardboard box I return to the reuse yard.
- My shipping charges are waived after I return a suitable number of boxes to the reuse yard.

Q31 I am likely to assign a cardboard box to the reuse process rather than assigning it to the recycling process if – (Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree , and Strongly agree) (NO QUESTION)

Q32 A charitable organization committed to preventing environmental degradation gets a suitable donation for each box I assign to the reuse process.

Q33 A charitable organization committed to helping Florida panthers from going extinct gets a suitable donation for each box I assign to the reuse process.

Q34 I get a suitable cash reward for each box I assign to the reuse process.

Q35 A charitable organization committed to keeping my city clean gets a suitable donation for each box I assign to the reuse process.

Q36 A charitable organization trying to reduce global warming gets a suitable donation for each box I assign to the reuse process.

Q37 I am likely to assign a cardboard box to the reuse process rather than assigning it to the recycling process if – (Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree , and Strongly agree) (NO QUESTION)

Q38 A charitable organization trying to repair the ozone layer gets a suitable donation for each box I assign to the reuse process.

Q39 I save money off my shipping charges for each box I assign to the reuse process.

Q40 A charitable organization committed to preventing the addition of trash into landfills gets a suitable donation for each box I assign to the reuse process.

Q41 A charitable organization committed to reducing pollution gets a suitable donation for each box I assign to the reuse process.

Q42 A charitable organization committed to helping polar bears from going extinct gets a suitable donation for each box I assign to the reuse process.

Q43 I am likely to assign a cardboard box to the reuse process rather than assigning it to the recycling process if – (Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree , and Strongly agree) (NO QUESTION)

Q44 I get a suitable discount on my favorite shopping brands for each box I assign to the reuse process.

Q45 A charitable organization committed to cleaning the trash in my city gets a suitable donation for each box I assign to the reuse process.

Q46 A charitable organization trying to decrease the depletion of fossil fuel gets a suitable donation for each box I assign to the reuse process.

Q47 A charitable organization committed to helping endangered species gets a suitable donation for each box I assign to the reuse process.

Q48 I get public recognition after I assign a suitable number of boxes to the reuse process.

Q49 I am likely to assign a cardboard box to the reuse process rather than assigning it to the recycling process if – (Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree , and Strongly agree) (NO QUESTION)

Q50 A charitable organization committed to keeping our environment clean gets a suitable donation for each box I assign to the reuse process.

Q51 A charitable organization committed to reducing climate change gets a suitable donation for each box I assign to the reuse process.

Q52 A charitable organization committed to preserving the environment for future generations gets a suitable donation for each box I assign to the reuse process.

Q53 I get a gift card for my favorite fast-food brand for each box I assign to the reuse process.

Q54 A charitable organization committed to decreasing dirty landfills gets a suitable donation for each box I assign to the reuse process.

Q55 I prefer driving sustainable electric cars over gasoline-powered cars.

Q56 I prefer environment-friendly fabric bags over cheap plastic bags in grocery stores.

Q57 I routinely donate food/money to the less fortunate.

Q58 I work hard to receive praise from my boss.

Q59 I avoid losing important documents by organizing them in the first place.