Trade-offs between Shopping Bags Made of Non-degradable Plastics and Other Materials Using Latent Class Analysis: The Case of Tianjin, China

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Abstract (50-100)

Tianjin, the fifth largest city, like other large cities in China, is suffering from severe environmental problems due to high plastic bag consumption. To curtail plastic bag consumption, a law has been enacted in China since June 1st, 2008 requiring large retail stores to charge for the bags. As a result, many plastic bag-manufacturing plants were closed. However, because of the popularity of plastic bags, they are still being manufactured and consumed. The premise of this study is that the popularity and charges for the current plastic bags of 0.3 CNY is too low to change customer's consumption behavior. The purpose of this study is to explore the attitude of people towards substitution of plastic bags with bags made from alternative materials and their willingness to pay for substitutes. This study used a conjoint choice experiment to measure Tianjin resident's preferences for degradable and non-plastic materials bags. The results show that most people do not like the non-degradable plastic bag and would use bags made of other materials if they were sold at a reasonable cost. Based on the latent class and socio-demographic segmentation results, there are preference distinctions among age groups. Also, there exists niche markets for paper, cloth, and degradable plastic bags where costs are of a lesser concern in consumer decisions. Manufacturers can use this information to more efficiently manufacture appropriate bags for different markets. This will help them maximize revenue while meeting demand.

Keywords: white pollution, plastic bag ban, conjoint choice experiment, willingness to pay, latent class analysis

Introduction

As people's knowledge of environmental pollution grows, prohibiting or discouraging the use of plastic bags has become a global imperative. Introduced just over 25 years ago, the consumption rate of plastic bags has grown to an estimate of over 500 billion plastic bags annually worldwide. An estimated four billion plastic bags end up as litter annually. Beginning as early as 1994, a number of countries began introducing legislation to ban the use of plastic bags. Some recent examples are: in 2005 France unanimously passed a law banning all non-biodegradable plastic bags by 2010 (France to ban non-degradable plastic bags 2005). Recently, Italy also passed a similar law (Italy set to ban non-biodegradable bags 2006). In the U.S. on March 28, 2007 San Francisco's City Council voted to become the first U.S. city to ban plastic bags at large supermarkets (Nzherald.co.nz, 2007). And in Hong Kong, a highly populated city, the government has been making great strides to reduce the use of plastic bags. Following the hugely successful ‘No Plastic Bag Day' campaign in 2006, which saw more than 40% decrease in use by participating retailers, the legislators in Hong Kong are now closer to passing an environmental levy on the bags to further cut the usage by one-billion bags per year (Hong Kong tremendously reduces plastic bag use 2006). Likewise, China has one-fourth of the world’s population and the economy is growing at a very fast pace with consumption of plastic bags per capita expected to be substantially high if the government does not intervene. Unless China begins to curtail the rampant consumption, the environmental implication to the world could be dire and long lasting.

Background

Thin plastic bags are very popular in China. China’s supermarkets reported consumption of 50 billion plastic bags in 2007 (China Packaging Industry 2008). Plastic bags are cheap and are considered sanitary to carry most things, including cooked food. However, using non-degradable plastic bags is an environmentally costly habit. The common sight of plastic bags everywhere has led to the creation of the phrase bai se wu ran, or "white pollution" named after the bag’s most popular color. Plastic bags are made from petroleum, a non-renewable resource and are extremely difficult to degrade. According to a survey by the China Plastics Processing Industry Association, to manufacture one billion super thin sacks per day for a year will require 37 million barrels of oil (Zaleski 2008). To prevent the white pollution, the Chinese government has launched a campaign to slowdown the use of plastic bags. Since June 1, 2008 China banned the production of ultra-thin plastic bags (defined as less than 0.025 mm or 25 microns thick). The government also banned supermarkets and larger retailers from giving out free plastic bags (Notice of the State Council on limiting production, sales and use of plastic bags, 2008). It is predicted that the ban will effectively drop consumption by two-thirds (Sohu.com, 2008). However, some experts argued that the prediction is far too optimistic because shoppers are still willing to pay for them as the price of bag costs only 0.3 Chinese Yuan (CNY), which is very cheap, compared to bags, made of other materials. Cloth bags cost as high as 3.0 CNY (Supermarkets facing the plastic bag ban are selling cloth bags 2008). Dr. Atiq Rahman, Director of the Bangladesh Center for Advanced Studies, a development think tank, confirmed the inelastic price demand for plastic bags when he said, "The trouble is [that] the plastic bag has become an integral part of life. We have learned [from Bangladesh's experience] that to say absolutely no to them is not an option. Most supermarkets and small shops now use paper bags, but there is still a demand for the very flimsy, thin plastic ones." (Vidal 2008). Experiences from Bangladesh and other countries showed that charging for plastic bags and banning production might not totally cease the use of plastic bags. The banning also creates negative socio-economic consequences. China's largest producer, Huaqiang Company, has already discontinued all manufacturing operations, not to mention the closing down of many small factories that produce plastic bags resulting in laying off many employees (SolveClimate.com 2008). Critics on the banning of plastic bags question whether the thin plastic bag's substitute, thicker plastic sacks and supposedly biodegradable ones, will ever deliver net substantial environmental, social or economic benefits.

Since the use of shopping bags made of plastic is a major environmental problem for China and there is a dearth of information on preferences for bags made with alternative materials, it is timely to find out preferences for plastic bag substitutes. If the information for preferred substitutes is known, it could lessen the negative socio-economics of the impacts. If 1.3 billion Chinese people continue to use plastic bags there will be immediate dire consequences on China's environment, which is already quite polluted in major cities such as Beijing, Shanghai, Guangzhou and Tianjin.

Objectives

The objective of this study is to find out consumer's preferences for shopping bags made with alternative materials and the tradeoffs among the important purchasing attributes of someone who purchases the bags. Specifically, this research objectives are (1) to evaluate the attributes of shopping bags that are important to consumers, (2) to determine the socio-economic demographics that might affect their buying preferences, and, (3) to discuss the results and marketing implications. To accomplish the objectives, a survey was conducted to find out consumer's preferences for bags made out of alternative materials and at what combination of price and other important bag attributes are more preferred by the consumers. This information can assist the manufacturers to produce bags, which are more environmentally acceptable and at the same time profitable. To accomplish the objectives of the study, several tasks had to be performed, (1) develop a conjoint choice experiment survey to collect data on consumer's preferences, (2) conduct the survey and collect data from several supermarkets in Tianjin (among the top 5 most populated cities), and (3) analyze the data with latent class approach and, (4) make conclusions and examine the implications.

Method

In this study, we will use Conjoint Choice Experiment (CCE) to find out Tianjin consumer preference for different types of shopping bags. The following paragraphs summarize previous studies using CCE and describe how the design of the CCE was developed.

Conjoint Choice Experiment (CCE)

The method chosen for this study is conjoint choice experiment. The CCE technique was initially developed by Louviere and Woodworth (Louviere and Woodworth 1983). As an empirical method, CCE originates in market research and transportation literature and has only relatively recently been applied to other areas such as the environmental studies discipline (Hensher 1994). Since mid-1990s CCE has been increasingly applied to various environmental problems. It has been used for valuating environmental amenities such as, the recreational moose hunting in Canada (Adamowicz, Louviere and Williams. 1994; Boxall, et al. 1996), woodland caribou habitat enhancement in Canada (Adamowicz, et al. 1996), preferences for deer stalking trips in Scotland (Bullock, Elston, and Chalmers 1998), and remnant vegetation in Queensland (Blamey et al. 1999). A summary of environmental applications is given in Hanley, Mourato, and Wright (Hanley, Mourato, and Wright 2001).

The CCE technique is based on the idea that any good can be described in terms of its attributes, or characteristics, and the levels that these attributes take. In our case of preference for shopping bags made of alternative materials to substitute for plastic bags, the shopping bags attributes are: costs, materials used to make the bags, number of times a bag can be reused, and the length of time it takes a bag to degrade naturally in the environment. The potential impacts from changing these attributes might impact purchasing decisions. Using CCE can tell us which attributes are significant determinants of the values people place when purchasing shopping bags. This information also tells us the willingness to pay for bags made with alternative materials. With this information, bag manufacturers can decide whether it is profitable to make bags using alternative materials instead of plastic.

Why We Choose the Conjoint Choice Experiment (CCE)?

This study through a survey of the Tianjin residents (with about 10 million residents) in China used a conjoint choice experiment method to elicit willingness to pay for alternatives to plastic bags. A conjoint choice experiment approach directly asks for respondent's preferences based on a set of structured survey questions. The approach measures the value of environmental goods and services by asking hypothetical scenarios and their valuations such as, alternative bag materials and shorter time for a bag to degrade.

A relatively new concept in environmental valuation, conjoint choice experiment is an evolved form of the more traditional conjoint analysis introduced in the 1980's. While the traditional conjoint analysis presents all the choices to respondents at one time, in conjoint choice experiment models, respondents typically are asked to evaluate a set of two profiles at a time with varying levels on each attribute. It then asks the respondent to pick the profile that they would most prefer from that set (Halbrendt et al. 2007).

Experimental Design of CCE

Table 1 shows the design stages of a CCE (Cattin and Wittink 1982; Green and Wind 1975; Halbrendt, Wirth, and Vaughn 1991).

Table 1: Design and Estimation Stages for a Conjoint Choice Experiment

Stage	Description
1.Selection of attributes	Selection of relevant attributes related to purchasing shopping bags. This is done through expert interviews and literature review. The interviews also help to identify the possible environmental impacts (attribute outcomes) important to respondents associated with using bags made of different materials, as well as the monetary cost of the bag.
2.Assignment of attribute levels	After identifying the important attributes, the range of each attribute is determined through literature review and expert interviews. The range or levels should be realistic and span over which we expect respondents to have preferences, and/or practically-achievable levels.
3.Choice of experimental design	Statistical design theory is used to combine the levels of the attributes into a number of alternative program profiles to be presented to respondents. Depending on how many choice sets and/or profiles are included in the experiment, one can have either complete or fractional factorial designs. In our case, we have a fractional factorial design to reduce the number of attribute level combinations while allowing the efficient estimation of the effects of the individual attributes ('main effects').
4.Construction of choice sets	The profiles identified by the experimental design are then paired and grouped into choice sets to be presented to respondents using a software program. In our study we used a program purchased from Sawtooth Software, Inc.

5.Method of collecting preference data	Choice of survey administration either with face-to-face interviews or mail surveying is needed to be decided depending on the complexity of the topic and project budget. This study chose face-to-face interviews as the survey approach is novel to enhance clarity to respondents.
6.Data estimation	Decide on the choice of the estimation method to achieve project objectives. One can use traditional logit analysis or latent class approach. In our study we chose latent class approach, as we believe this is a more appropriate estimation tool when dealing with people generally of heterogeneous background.

In order to come up with the important attributes and their levels on what purchasing attributes consumers will consider when substituting plastic bags, literature reviews and interviews were conducted. Literature reviews involved reading papers in the relevant field and searching information on the Internet. In-depth interviews involved discussion with random residents. The first step of our CCE design was to find the product attributes and levels. Studies such as Tang et al,. (Tang, Guo, and Wan 2003) and Wang and De (Wang and De 2008) have shown that attributes such as materials, costs, number of reuse times, degradable period and extent of damage to the environment are important factors for the consumers when they make their choices of what shopping bags to use. After extensive literature review and interviews, the four most important attributes selected were (1) type of material use to make the shopping bags, (2) cost of each bag of a medium size (a bag that holds approximately 6 kilograms) (3) number of times the bag can be reused, and (4) how long it takes for the bag to degrade naturally in a landfill. The rationale for selecting them is:

(1) Material

Through literature review (Tang, Guo, and Wan 2003) and direct observation in the city, we have decided on four types of the material: non-degradable plastic, degradable plastic (distinguished from the non-degradable one by a logo), paper and cloth.

(2) Cost

Cost is usually a vital economic factor that affects decision making of consumers. When deciding on the levels of this attribute, the researchers collected the prices of plastics, paper, and cloth bags from many large supermarket and retail stores with the findings of the average price per bag ranging from 0.3 to 3.0 CNY. Supermarkets in Tianjin currently are charging 0.3 CNY for a medium size bag. A cloth bag of comparable size costs 3.0 CNY each, and a paper bag costs about 1.5 CNY. Thus, the levels used for this study are 0.3, 1.5 and 3 CNY per bag.

(3) Number of times a bag can be reused

The levels of this attribute were determined by randomly interviewing 30 consumers in Tianjin city. Interviewers asked random consumers how many times they use each kind of bag (non-degradable and degradable plastics, cloth and paper) before they throw it away, the answers were mostly 1, 5 and 30. For this study, the levels chosen are 1, 5 and 30 times.

(4) Degradation time for bag materials

How long it takes a certain material to degrade was identified as an important environmental attribute through literature reviews. Degradable plastics, paper and cloth degrade in the natural environment between 45 to 90 days (Tang, Guo, and Wan 2003). And non-degradable plastics takes a very long time to degrade. Therefore the levels for this attribute are: 0.125, 0.25 and 100 years (or representing infinity).

Table 2: Attributes and Their Levels

Attributes	Levels			
Material	Non-degradable plastics	Degradable plastics	Cloth	Paper
Cost/bag (CNY)	0.3	1.5	3	
Times to reuse	1	5	30	
Degradation (year)	0.125 (1.5 months)	0.25 (3 months)	100 years	

The third and fourth stages of designing the CCE involve choice of experimental design and construction of interview design questions to be presented to survey respondents. Program profiles are constructed by selecting one level from each attribute and combining across attributes. In this study, there are four attributes with one having four levels and the rest having three levels each, such that the number of possible profiles totaled 4x3x3x3 or 108. A complete factorial design would use all the 108 profiles, which is undesirably difficult for respondents to evaluate and make decision from. So instead a fractional factorial design is proposed. A fractional factorial design is a sample of attribute levels selected from a full factorial design without losing information to effectively test the effects of the attributes on respondent's preference (Halbrendt et al. 2007). The most commonly used method of constructing fractional factorial design in conjoint measurement is the orthogonal array. Orthogonal arrays build on the Graeco-Latin squares by developing highly fractionated designs in which the scenario profiles are selected so that the independent contributions of all main effects are balanced, assuming negligible interactions (Green and Wind 1975). This study constructed different profiles based on degrees of freedom requirements to estimate all of the main effects within the orthogonal design (Louviere 2000). From all possible profiles, pairs of profiles were randomly developed and separated into 7 sets of 12 pairs using software developed by Sawtooth, Inc. Having only 12 pairs to evaluate from ensure the surveying exercise does not adversely impact a respondent's responses.

For data collection, the designed experiment was carried out. Each respondent is presented with one set of 12 pairs of profiles to make their choices from. The experiment requires respondents to choose one product profile from each pair. Table 3 shows an example of a pair of product profile scenarios for respondents to choose from.

Table 3: Example of a Pair of Product Profile Scenarios

Attributes	Program A	Program B
Material	Non-degradable plastics	Cloth
Cost/bag (CNY)	0.3	3.0
Number of Times to Reuse	5	10
Degradation Period (year)	100	0.25 (3 months)

Data collection

Survey Location

Tianjin is a modern industrialized city more typical of Chinese urban areas as the influence from foreign tourists is less than other international metropolitan cities such as Beijing and Shanghai. The survey was conducted mainly in supermarkets and vegetable and fruit markets where respondents are random residents of Tianjin. Supermarkets are also places where most plastic bags are used and where the plastic bag is banned from giving them out free of charge.

Table 4: Locations and sample size

District, City of Tianjin	Survey Location	Sample size
Nankai	Renrenle Supermarket	30
	Good Harvest Supermarket	30
Hebei	Carrefour Supermarket	30
	Vanguard Supermarket	28
	Milan Supermarket	27
Heping	Vegetable Market	30
Hedong	Vegetable Market	30
Total		205

Sample Population

Two hundred and five surveys were completed during 11 days from June 10th to June 20th, 2008. Table 5 shows the socio-demographic of respondents and is compared with the Census data of Tianjin residents. About 60.5% of the respondents were female and 39.5% were male in the survey whereas the population of male residents of Tianjin is 49.6% over 50.2% female. The gender distribution of the respondents has more females and does not exactly match the demographic characteristics of Tianjin. It can be explained that generally more females do the shopping than male respondents in China. There were more young respondents in the sample. For the same reason, younger people shop more than older people. The household income of respondents is somewhat similar with the household income of Tianjin residents. Forty-eight percent of the respondents have a monthly household income less than 3,000 CNY, thirty-one percent of them have a monthly household income range from 3,000 to 5,000 CNY, and twenty percent of the respondents have a monthly household income of over 5,000 CNY. In comparison to the educational background of Tianjin residents, the respondents have the following training: Elementary school diploma (19.0%) and Junior high school diploma (31.7%) which matched well with the demographic characteristics of Tianjin, while more respondents have high school diploma (48.8%) and less have College degree and above (0.5%). This can be explained that more educated people do less shopping for food and dry goods for daily consumption. Overall, the survey respondents are shoppers from different socio-demographic background and in most instances matched well with Tianjin resident's profile except that they are younger and more respondents have a high school education.

Table 5: Socio-demographic of Survey Respondents

		Survey Respondents (%)	Tianjin residents (%)
Gender	Female	60.5	49.6
	Male	39.5	50.4
Age*	16-29	41.9	25.4
	30-39	20.0	17.4
	40-49	17.1	21.8
	50 and over	21.0	35.4
Income	<￥3，000	47.8	40.0
	≥￥3，000 to <￥5，000	30.7	40.0

	≥￥5，000	21.5	20.0
Education	Elementary school diploma	19.0	21.9
	Junior high school diploma	31.7	37.7
	High school diploma	48.8	21.9
	College degree and above	0.50	14.1

*People under 16 were not interviewed because they are still in secondary school.
Source of Tianjin resident's data: Tianjin Census Book 2007 (ISBN 978-7-5037-5127-1/F 12427)

Sample Size

Based on an analysis of 21 CCE studies, Orme, (2006) concluded that increasing the number of choice sets for each respondent can obtain very similar statistical gains proportional to a greater number of respondents. Thus, Orme (2006) recommends that a general sample size ranges from 150 to 1,200 respondents. This study completed 205 surveys, which are within the range recommended by Orme's study, and each respondent were provided with 12 choice sets to choose from.

Survey Instrument

The survey questionnaire is consisted of two sections. Section one is the set of 12 pairs of shopping bag profiles for respondents to choose from. Section two consists of questions regarding the socio-demographic and economic background of the respondents such as age, income, education and other characteristics. Section one data provides the attribute-specific preferences. The data is analyzed using latent class analysis software Latent Gold Choice, Version 4.0 developed by Statistical Innovations Inc.

Survey Technique

Data were collected using face-to-face interviews. To establish a minimal level of knowledge on the issue prior to completing the survey, a brief description of the law banning plastic bags and its potential impacts were read to every respondent regardless of their knowledge on the law and environmental impacts. Then, they were given 12 pairs of product profiles with differing levels of attributes and asked to choose one from each pair. The response rate was 80%.

Conjoint Choice Model Using Latent Class Analysis (LCA) Approach

LCA is used to evaluate respondent choice behavior by capturing both observable attributes of choice and unobservable factors found in the heterogeneity of individual's behavior (Greene and Hensher 2003; Milon and Scrogin 2006). In other words, respondents are placed into distinct classes (groups) based on their choices when answering the conjoint choice experiment questions. In LCA studies, the probability of making a specific choice among a pair of product profiles is based on the perceived value of product attributes, and covariates of respondents (such as respondent's age and income) (McFadden 1974). The value respondents placed on product attributes and respondents' socio-demographic factors were major factors valuated in this study.

In a conditional logit model, the probability (P_{ni}) that individual n chooses profile i can be represented by the following equation (McFadden 1974):

(1) $$P_{ni} = \frac{\exp(\eta X_{ni})}{\sum_{h=1}^{I} \exp(\eta X_{nh})}$$

Where η denotes a scale parameter, usually normalized as 1.0. X_{ni} is the deterministic component that is assumed to be a linear function of explanatory variables. Equation (1) can be represented as equation (2) for LCA:

(2) $$P_{ni} = \frac{\exp(\eta \beta Z_{ni})}{\sum_{h=1}^{I} \exp(\eta \beta Z_{nh})}$$

Where Z_{ni} are explanatory variables of X_{ni}, including a profile-specific constant, product attribute of profile i, and socio-demographic factors of respondent n. β is a vector of estimated parameter coefficients.

In a latent class analysis, respondents are sorted into M classes (groups) in terms of individuals' choice of observable product attributes, and the unobservable heterogeneity among the respondents. The value of estimated parameter coefficient β is different from class to class because this parameter coefficient is expected to capture the unobservable heterogeneity among individuals (Greene and Hensher 2003). Then, the choice probability of individual n belong to class m (m = 1, …, M) can be expressed as equation (3):

(3) $$P_{ni \mid m} = \frac{\exp(\eta_m \beta_m Z_{ni})}{\sum_{h=1}^{I} \exp(\eta_m \beta_m Z_{nk})}$$

Where η_m is the class-specific scale parameter and β_m is the class-specific estimated utility parameter. The software program used to analyze the conjoint choice and the socio-demographics data was Latent Gold Choice 4.0, an analytical tool developed by Statistical Innovations, Inc.

The first step of the latent class analysis was to determine the optimal number of distinct classes for the dataset. Using the Bayesian Information Criterion (lowest BIC value for best results), which was first proposed by Schwarz (Schwartz 1978), it was shown that the five-class model was needed to provide the best grouping for the dataset.

Results

LCA model specification

The probability for individual *n* in class *m* choosing shopping bag *i* is measured by two types of characteristics: (1) shopping bag attributes, including cost (C), bag materials (M), number of reuse times (T) and time it takes to degrade naturally (D); and (2) individual socio-demographic factors, including age (A), gender (GE), household income (HI), education (ED) and household plastic bag consumption per week (CO). The preference model is specified in equation (4).

(4) P (*i*) = f (C, M, T, D, A, GE, HI, ED, CO)

where:

P (i) = Probability of choosing product A vs. B,

C = Shopping bag cost, taking values of 0.3 CNY, 1.5 CNY, or 3.0 CNY,

M = Types of materials, biodegradable plastics, degradable plastics, paper and cloth,

T = Number of reuse times, taking values of 1, 5 and 30,

D = Time it takes for the material to naturally degrade, taking the values of 1.5 month, 3 months, and 100 years.

A = Age group:16 to 18, 19 to 29, 30 to 39, 40 to 49, 50 and above.

GE = Gender, Male or Female.

HI = Household income group (per month) : <3,000 CNY, 3,000 to 5,000 CNY, and > 5,000 CNY.

ED = Educational attainment group: elementary school diploma, junior high school diploma, high school diploma, bachelor degree and above.

CO = Plastic bag consumption per week, per household: <10, 10 to 20, and >20.

Latent Class Analysis

The results in Table 6 show the estimated parameters, signs and their significance levels for each class. Of the four attributes shown, the significant attributes that determined the bag choice for Class 1 are degradable plastics (+ sign) and non-degradable plastics (-), cost (-) and degradation period (-). Therefore, Class 1 respondents prefer degradable material, lower cost and less time for the material to degrade naturally. These signs are expected and significant at the 0.05 or 0.01 levels. For Class 2, the significant attributes found in this group are degradable (+) and non-degradable plastics (-), reused times (+), and degradation period (-). Again, the signs are expected and they are all significant at the 0.01 level. Cost has the expected negative correlation in this class, but was not significant. Class 2 prefers degradable plastics and bags that can be use many times but do not prefer non-degradable plastic bags that take a long time to degrade. Cost and bags made of either cloth or paper are not important for this group. For class 3, the significant attributes are cloth (+), non-degradable plastics (-), paper (+), and time it takes to degrade (-). These parameters are all significant at the 0.05 level. In Class 4, all parameters except for degradable plastics and paper are significant and have the expected signs. Class 5 respondents do not prefer high cost (-). They prefer paper (+), and higher number of times the bag can be reused (+). These parameters are significant at the 0.05 or 0.01 level.

Table 6: Parameter Estimates of the Five Classes

Attributes	Class 1	Class 2	Class 3	Class 4	Class 5
Material					
Cloth	0.1483	-0.0064	1.3825**	0.4491*	-0.0624
Degradable plastics	0.2626**	0.6057**	0.0947	0.0918	-1.1506
Non-degradable plastics	-0.2565*	-0.7898**	-2.9304**	-0.9790**	-0.9627
Paper	-0.1544	0.1905	1.4533**	0.4381	2.1756**
Cost	-0.0971*	-0.1378	-0.1642	-0.6943**	-2.8350**
Times to use	0.0016	0.0442**	0.0100	0.1278**	0.0470*
Degradation	-0.0040**	-0.0445**	-0.0120**	-0.0117**	-0.0131

* significant at 0.05 level, **significant at 0.01 level.

A relative attribute importance test for all the attributes was calculated to determine their rankings within each class (Table 7). For Class 1, the type of material (42.29%) is the most important attribute followed by degradation period (32.69%) and cost (21.35%). The number of reuse times (3.67%) is the least important for Class 1 respondents. This is a group balances between choosing an environmentally friendly material (*degradable plastics*) and reasonable cost. Class 2 shows degradation period as the most important factor (59.31%) followed by the type of material (18.62%) and the number of times a bag can be reused (17.10%), then the cost (4.97%). This group is more of an ‘*idealist*’ group that places environment with less non-degradable plastics as very important regardless of cost. The type of material (69.36%) is the most important factor for the Class 3 group, followed by degradation period (19.02). The cost (7.02) and number of reuse times (4.6%) are less important for this group. Class 3 is the ‘*no plastics’* group. For Class 4, which is different from other classes, the number of reused times is the most important attribute (45.32%), followed by cost (22.91%), material (17.46%) and degradation period (14.31%). This is the *‘practical’* consumption group. Class 5 is the only class in which cost was the most important (56.05%) factor, followed by type of materials (24.36%), number of reuse times (9.98%) and degradation period (9.615). Group 5 is the ‘*cost conscious’* group. The above showed that each class weighs the product attributes differently.

Table 7: Relative Importance of Each Class in Percent and Significant Socio-demographics

Program Attributes	Class 1	Class 2	Class 3	Class 4	Class 5
Material	42.29%	18.62%	69.36%	17.46%	24.36%
Cost	21.35%	4.97%	7.02%	22.91%	56.05%
Times	3.67%	17.10%	4.6%	45.32%	9.98%
Degradation	32.69%	59.31%	19.02%	14.31%	9.61%
Significant Socio-demographics	All ages except 40-49	Ages 16-18	Not significa nt	Ages 40-49	Not significant
% of Respondents	30.3	26.6	19.2	16.24	7.76

Respondents in the same class share similar utility, however each class put different weights on each attribute. In order to find out the respondent’s characteristics of each class, we evaluate the significant socio-demographic information according to the classes. The only demographic variable significant is age for three classes. This signifies that age has a large influence on consumer preferences for shopping bag attributes. Below is the summary of the results of each class by attribute importance and age.

Class 1 is the largest group with 30.3% of the respondents. Respondents in this group are less likely to be between ages of 40-49. This is the *‘degradable plastics’* group. They prefer degradable plastic bags, likes the material to degrade fast and low cost.

Class 2 is the environmentally conscious, ‘*idealist*’ and younger age group with 26.59% of the respondents. The respondents from this class mainly come from residents aged between16-18 and they place a significant weight on how long it takes for the bags to degrade naturally in a landfill regardless of cost.

Class 3 places the type of material as the most important decision attribute with 19.12% of the respondents. Respondents in this class place about 70% of the weights on the type of materials used to make the bags. They significantly prefer paper and cloth and generally they are less concern with the number of times the bags can be reused or the cost of the bag. This is the '*no plastics*' group.

Class 4 is the group with 16.24% of the respondents. Respondents in this class are between ages 40-49. They are the '*practical*' consumption group that cares a lot about the number times the bags can be reused (45.32%). They also place importance on the cost (22.91%). The consumers in this group generally are the main wage earners in their families. This group shops a lot and they prefer cloth bags, which can be used many times.

Class 5 is the '*cost conscious*' group with 7.76% of respondents. Cost is the most important attribute of their choice (56.05%), followed by the types of material used to make the bags (24.36%). They prefer paper bags and care less on the degradation time of the bags (9.61%) and reused times (9.98%).

Valuation of Alternative Materials Used to Make Environmental Friendly Bags using Expenditure Equivalent Index (EEI)

One of the purposes of this study is to examine respondent's willingness to pay for alternative materials that have environmental implications. Holding other attributes and their levels constant, while independently changing the significant bag materials for each class, the expenditure equivalent index (EEI) of this attribute can be estimated. EEI is used to measure the change in price corresponding to the change in product attribute which in this study is the bag material (Payson, 1994).

This study uses equation (5), which was developed by Payson (1994), to calculate the EEI of alternative materials for the five classes.

$$EEI_j = 1 - \frac{\sum_{j=1}^{J} \beta_j B_j}{\theta C} \qquad (5)$$

Where, β_j is the estimated parameter for the attribute j, B_j is the change of the levels in the attribute j, θ is the estimated parameter for cost, and C is the base level of cost. In this case, the base level of cost is 0.3 CNY, which is the cost of non-degradable plastic bags. Using the baseline as a comparison, the EEI shows the proportional changes in respondents' average willingness to pay (WTP). Thus, respondent's WTP for alternative materials, which have corresponding environmental implications, can be calculated by multiplying the EEI with base cost of 0.30 CNY. The results are presented in Table 8.

Table 8: WTP for shopping bags made with alternative materials to non-degradable plastics

Attributes	Class 1	Class 2	Class 3	Class 4	Class 5

	EEI	WTP	EEI	WTP	EEI	WTP	EEI	WTP	EEI	WTP
Non-Degradable Plastics (Base case)	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30
Degradable Plastics	10.01	3.00	15.65	4.70	--	--	--	--	--	--
Paper	--	--	--	--	30.50	9.15	--	--	3.56	1.07
Cloth	--	--	--	--	29.07	8.72	3.16	0.95	--	--

Note: -- means that WTP was not calculated as the parameter for this material in the specific class was not significant.

The baseline bag used for EEI calculation is the current non-degradable plastic bag at 0.3 CNY per bag, that can be reused 3 times, and takes a long time to degrade. The table shows that for all the classes, Class 1 and Class 2 are willing to pay more for degradable plastic bags, Class 3 and Class 5 are willing pay more for paper bags, and Class 3 and Class 4 are willing to pay the more for cloth bags. The table also shows that for degradable plastic bag the range of additional WTP per bag is from 3.0 to 4.7 CNY. For cloth bags, the range of WTP is from 0.95 to 8.72 CNY and for paper, the WTP range for paper is from 1.07 to 9.15 CNY. The WTP range is largest for paper then followed by cloth and then degradable plastics with a much smaller range. Class 3, the *'no plastics'* material group stands out as the group of respondents that are willing to pay a lot for cloth and paper made bags. Since the degradable plastics material is not significant in this class, it be can considered that respondents in this class do not care about plastics whether they are degradable or not. Also, it appears that certain consumers are willing to pay at least 1.0 CNY more for cloth or paper bags. Finally, degradable plastic bags are quite popular with a large segment of the population as 56% of the respondents are willing to pay between 3.00 to 4.7 CNY more per bag. From the results manufacturers can compare the WTP with their production costs to decide which alternative materials they can produce and whom to sell them to in order to make a profit and yet be environmentally friendly.

Conclusions

Results of this study show that demographics impact the consumer preference for shopping bags made with different materials. In this study age has a large influence on consumer preferences for the type of shopping bags they buy. Consistently, respondents do not prefer non-degradable plastic bags. Preferences for other materials vary as some groups of consumers prefer cloth and others prefer paper or degradable plastics. For a majority of the respondents, cost was negatively correlated as expected, but for 2 classes they were not significant meaning cost was not a factor when purchasing bags. For the two attributes: 'numbers of times of reusing a bag' and 'years it takes for the bag to naturally degrade', the signs are as expected, positive for increasing the number of reuse times and negative for increasing years needed to degrade the bag naturally. Several groups did not show a significant value for those two attributes.

The implications of the results highlight the need for finding a substitute for non-degradable plastic bags. Consumers and producers will benefit from a change in the current production and use pattern. In general, residents of Tianjin prefer lower cost, bags that can be used many times but that have a faster rate of degradation . However, from a marketing standpoint, there are about 26% of the population that strongly prefer purchasing shopping bags not made with non-degradable plastics and some willing to pay up to 4.7 CNY per bag. However, if a bag manufacturer wants to produce a shopping bag that appeals to a broader base, the shopping bag should be made of degradable plastics, at reasonable cost and degrade fast in a natural environment. Interestingly, the results indicate that a lot of consumers still prefer plastics, though they must be degradable, as plastic bags are not bulky to take along, are sanitary, can carry both dry and wet goods and are waterproof.

Finally, there are niche markets that can be developed for bag manufacturers. This study found that there are some who only prefer paper or cloth bags and are willing to pay much more than their current expenditures. This study sets out to explore consumer's preferences in Tianjin for shopping bags made with materials other than the highly undesirable environmentally unfriendly plastic bags. Results showed that given reasonable costs, bags made with different materials, particularly with degradable plastics, are popular with consumers. For marketing purposes, as shown in this study, different types of shopping bags catered to different socio-demographics. Bag manufacturers should capitalize on the market information provided in this study to maximize their revenues.

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